INFLUENCE OF A MOUNTAIN RESERVOIR ON THE FLOW REGIME, SEDIMENT, AND BIOTA OF THE RECEIVING STREAM

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Influence of a Mountain Reservoir on the flow Regime, Sediment, and Biota of the Receiving Stream

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ABSTRACT

Selected hydrological, physicochemical, and biological parameters were measured from May 1979 to April 1980 to evaluate the effect of reservoir construction on a high mountain stream. Construction had no apparent effect on stream discharge, pH, dissolved oxygen,organic or inorganic fractions of total dissolved solids, bound carbon dioxide, or substrate permeability. Results for substrate composition and fish sampling were inconclusive. However, the organic and inorganic fractions of suspended solids at least doubled and thermal alterations occurred immediately downstream from construction activities; sites farther downstream displayed relatively rapid recovery. There were definitive reductions in epilithon biomass, macroinvertebrate density, and macroinvertebrate biomass downstream from construction, and although some recovery occurred at sites farther downstream, compositional changes were apparent. The relatively high gradient of Joe Wright Creek combined with the ameliorative action (i.e., dilution) of its tributaries were largely responsible for the rapid recovery found at sites farther downstream from construction. Caution is advised in the broad application or interpretation of these findings because only selected parameters were measured, sampling took place over a relatively short period of time, and long term or sublethal changes may not have been detected by the methods employed.

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INTRODUCTION

In March 1979, the U. S. Forest Service awarded a grant in the amount of $7000 under the guidelines of The Eisenhower Consortium for Western Environmental Forestry Research [Coop. Agreement 16-895-GR (EC 310)] to James V. Ward and Clarence A. Carlson of Colorado State University. This grant partially supported a second year of research on the effects of reservoir construction on Joe Wright Creek, a small high mountain stream.

In order to assess the effects of reservoir construction, the following objectives were formulated:

1. To determine the composition and density of fish, macroinvertebrates, and algae in Joe Wright Creek as modified by reservoir construction. Specific questions included:

    a. What species of fish and macroinvertebrates, and what common genera of algae occurred in impacted and unimpacted stream sections?

    b. What was the standing crop of these groups in impacted and unimpacted stream sections?

    c. What was the diversity of the fish and macroinvertebrate communities in impacted and unimpacted stream sections?

    d. How did construction activities affect the food habits, growth, and condition of fishes?

2. To determine the relationship of the composition and density of the stream biota to the physicochemical characteristics of the habitat at each site as modified by reservoir construction. Specific questions included:

a. What were the normal levels and variations in temperature, pH, hardness, oxygen, and suspended and dissolved organic and inorganic matter? How were these parameters influenced by reservoir construction? How were the biota affected by the physicochemical changes in the stream environment?

b. What was the particle size composition of impacted and unimpacted substrates? How were the biota affected by changes in substrate composition?

JOE WRIGHT RESERVOIR CONSTRUCTION

Joe Wright Reservoir construction activities occurred during the ice-free months of 1977, 1978, and 1979. The original dam, 12.2 m high and capable of retaining 1,004,000 m^3 of water, was removed in 1977 and vegetation was cleared to the new dam's highwater mark. The new dam and outlet structure, completed in December 1979, is 36.6 m high at an elevation of 3042 m; normal water surface elevation will be 3038 m at which water storage will be 8,382,000 m^3.

JOE WRIGHT CREEK

Joe Wright Creek is a small high mountain tributary of the Big South Fork of the Cache La Poudre River and lies within Roosevelt National Forest and Larimer County approximately 113 km northwest of Fort Collins, Colorado (fig. 1).

The stream's highest elevation is 3132 m. It flows approximately 22.2 km before entering the Poudre River at 2545 m elevation. Average slope is 3.0% with a maximum of 5.0% and a minimum of 2.2% (fig. 2). The drainage

basin, exclusive of transmountain diversion inputs, constitutes an area of approximately 95.8 km^2, 73% of which is wooded. Soils are basically granitic (Fuqua 1974).

Nine study sites were chosen to acquire maximum information pertaining to the effects of reservoir construction on the receiving stream. Two sites (1H and 1) above the reservoir were used as control sites. Seven sites (2DAM, 2, 2GS, 3U, 3, 4, and 5) below the reservoir were chosen to demonstrate recovery as a function of distance from construction activities as well as recovery because of the dilution effect of tributaries.

Site 1H. Elevation: 3046 m. This site was located at the upstream side of the culvert where Route 14 crosses Joe Wright Creek above the reservoir, approximately 2.4 km east of Cameron Pass.

Site 1. Elevation: 3043 m. This site was located approximately 200 m downstream from site 1H and an unnamed tributary. Riparian vegetation consisted of willows, grasses, and sedges. Streambed morphology was characterized by long riffles with an occasional pool and a few undercut banks. The substrate consisted of gravel, pebble, and cobble. The U.S. Geological Survey operated a water depth recorder at this site (USGS site #06746100; elevation: 3045 m).

Site 2DAM. Elevation: 2989 m. This site was located immediately below the dam. Thermal data were taken about 50 m downstream from the outlet.

Site 2. Elevation: 2971 m. This site was located approximately 300 m downstream from site 2DAM. Much of the riparian vegetation at sites 2DAM and 2 was removed or disturbed and rock used in dam construction covered most of the stream's original substrate. Streambed morphology was characterized by cobble and gravel in long riffles with few pools or undercut banks.

Site 2GS. Elevation: 2960 m. This site was located approximately 200 m downstream of site 2. The U.S. Geological Survey operated a water depth recorder at this site (USGS site #06746110).

Site 3U. Elevation: 2938 m. This site was located 450 m upstream of the North Fork of Joe Wright Creek. Riparian vegetation consisted of willows, sedges, grasses, and conifers. Compared with all other sites, this site had the lowest gradient and undercut banks were the most abundant, totalling about 75 m of streambank.

Site 3. Elevation: 2926 m. This site was located approximately 150 m upstream of the North Fork of Joe Wright Creek. Numerous small permanent and intermittent tributaries entered between sites 2 and 3. Riparian vegetation consisted of willows, grasses, and sedges. Pools and riffles alternated irregularly with cobble and gravel as dominant substrate components. A few undercut banks were present.

Site 4. Elevation: 2896 m. This site was located where State Highway 14 crosses Joe Wright Creek, approximately 500 m downstream of the North Fork of Joe Wright Creek. Dense conifers occurred on both sides of the stream with some willows occasionally present. Pools were common and occasionally long and deep. Substrate consisted of boulders, cobble, and gravel.

Site 5. Elevation: 2789 m. This site was located immediately upstream from Chambers Lake. Willows, alders, and grasses predominated although some conifers were present. Pools were common and occasionally deep. Boulders, cobble, and gravel were the dominant components of the substrate.

METHODS

Discharge. Discharge values were calculated from stage height-discharge rating curves supplied by the U.S. Forest Service. Stage height readings were made at sites 1H, 2DAM, 2, 3, and 4. Mean daily discharge values for sites 1 and 2GS were supplied by the U.S. Geological Survey.

Water Temperature. Weekly thermal minima and maxima were recorded from Taylor Maximum-Minimum thermometers which were calibrated against a clinical grade thermometer.

To provide continuous thermal records immediately above and below reservoir construction, a Foxboro thermograph was located at site 1 and a Ryan thermograph was located at site 2DAM. Both instruments were calibrated against a clinical grade thermometer during use in the field.

Substrate. Substrate was sampled with a steel core of approximately 25 cm diameter. After forcing the core into the substrate, all material was removed to a depth of several centimeters and returned to the laboratory. One sample each was taken in fast water (erosional) and slow water (depositional) areas. The substrate was dried, separated into size classes with sieves, and weighed.

Determination of the sand, silt, and clay fractions was made by the Colorado State University Soil Testing Lab using the hydrometer method.

Mean (geometric) particle size was computed from: $dg = \sqrt{d_{16} d_{84}}$ where d_{16} and d_{84} correspond to the 16th and 84th percentiles extrapolated from a graph of cumulative percentage composition by weight versus log particle size (Platts *et al.* 1979).

pH. The pH was measured in the field with Hellige color comparator discs. This technique was accurate to about 0.1 unit.

Dissolved Oxygen. Samples were collected in 300 ml BOD bottles and all determinations were performed in the field using the azide modification of the Winkler Method. Percentage saturation was computed with corrections for barometric pressure and temperature.

Hardness (Bound Carbon Dioxide, i.e., $CaCO_3$). At each site, 250 ml of water were collected and one drop of chloroform added. Samples were transported to the laboratory in an ice chest. Hardness was determined by titrating 100 ml of water with 1/44 HCl, using a methyl orange indicator solution.

Suspended and Dissolved Solids. At each site, 1 liter of water was collected with a DH-48 depth integrating water sampler and four drops of chloroform were added. Samples were then transported to the laboratory in an ice chest. The water was filtered through Millipore filters with 5 and 0.45 micrometer apertures. The suspended solids retained by the filters were dried, weighed, ashed at 600°C then weighed again to determine loss-on-ignition (an estimation of the organic portion). The filtered water was evaporated at 60°C in a sand bath. The residue (total dissolved solids) was dried, weighed, ashed at 600°C then reweighed to determined loss-on-ignition (organic portion).

Epilithon. Algae and associated materials attached to rocks were collected by scraping the surfaces of rubble-sized stones with a scalpel. Using a rubber template, an area of 6 cm^2 was scraped from the surface of ten different rocks for a total of $60 cm^2$. The sample was preserved in 5%

formalin until the relative contribution of major components was determined and the common genera identified. The samples were then dried, weighed, ashed at 600°C and reweighed to obtain loss-on-ignition (organic portion) per sample.

Macroinvertebrates. Ten samples were taken at each site to estimate macroinvertebrate density. Each core sample enclosed 476.8 cm^2 of stream substrate to a depth of about 5 cm. The core was driven into the substrate and a small net with 250 micrometer mesh was used to remove surface dwelling macroinvertebrates. Larger rocks were removed and individually examined for macroinvertebrates. The majority of material remaining within the core was placed in a bucket of water and the macroinvertebrates were elutriated through a sieve of 250 micrometer mesh. Finally, further sieving of the water in the core with the small net was performed to remove the remaining macroinvertebrates.

The ten samples were divided between slow (depositional) and fast (erosional) areas of substrate. An average water depth and current speed was calculated for each set of slow and fast water samples.

Macroinvertebrates were identified using Baumann et al. (1977), Pennak (1978), Merritt and Cummins (1978), Smith (1968), and Mason (1973).

Fish. Fish were collected with a backpack electrofishing unit. Stream subsections of 25 m were measured and flagged prior to collection activities. A total stream length of 200 m was sampled at sites 1, 2, and 4. At site 3, two areas of 200 m were sampled and at site 5, a section of 100 m was sampled.

Weight, length, and scales were taken from each fish collected prior to release. Some released fish were tagged with a modified Carlin interneural tag just posterior to the dorsal fin or with a subdermal tag (Butler 1957) ventrally.

Selected fish were sacrificed for their stomach contents which were preserved in 10% formalin until processed.

For age determinations, the scale samples were soaked in 0.1 M NaOH solution for approximately five minutes and examined under a binocular dissecting microscope prior to mounting between two glass slides. The scales were then magnified at 80X using an Eberbach Scale Projector and analyzed on two different occasions using criteria outlined by Bagenal (1978). Age and growth parameters were estimated using data from individual fish, rather than from group averages which result in slight overestimates (see Ricker 1975).

Preserved fish stomachs were opened and their contents placed in a petri dish for separation into major taxa. Where possible, lower taxa were identified. Volumetric determinations of major taxa were made with a graduated centrifuge tube. Taxa percentages by number and frequency of occurrence were also determined.

Feeding selectivity was measured with Ivlev's Electivity Index:

$$\text{Electivity} = \frac{r_i - p_i}{r_i + p_i}$$

where r_i = relative abundance of food items in the gut contents, and

p_i = relative abundance of food items in the environment.

Electivity values were calculated from stomach contents of fish collected at site 1 on 29 August and 22 September. Macroinvertebrate relative abundance data were taken from samples collected on 6 and 21 September.

Permeability. Permeability measurements were made using the equipment and methodologies reported by Terhune (1958). All values were corrected to a water temperature of 10°C.

RESULTS AND DISCUSSION

A summary of the 1979 sampling dates and parameters measured is provided in table 1.

Discharge. There was no apparent change in the discharge regime below reservoir construction activities based upon mean daily discharge values at sites 1 and 2GS (tables 2-3, fig. 3). Discharge pulses occurring at site 1 were paralleled both in magnitude and time at site 2GS.

Snow meltoff began in mid-May and peaked during 12-18 June, followed by another smaller pulse in late June (figs. 3-4). Subsequently, precipitation related discharge pulses occurred in mid-July and mid-August. Return to base flow occurred at site 1 in late September and presumably shortly later at other sites, as exemplified by site 2GS (fig. 3).

Sites 1H, 3, and 4 displayed the greatest diel discharge variation on 13-14 and 18-19 June (tables 4-6, figs. 5-6). Typical of an unregulated stream during snowmelt runoff, the lowest discharges and highest percentage variations (up to 100%) occurred at the uppermost site, site 1. Downstream, discharge values were higher and diel variation lower (less than 45%) at sites 3 and 4. (Discharge data are not available for sites 2DAM and 2 because stage height-discharge rating curves were not available from the U.S. Forest Service.)

Alteration of these flow regimes, beyond the normal year-to-year variations, by reservoir operation likely would exert an effect on biotic productivity and stream fauna composition (Ward 1976a, Ward and Stanford 1979).

In one respect, the discharge patterns of 1979 and 1978 (Cline and Ward 1979) were similar. Snowmelt runoff peaked in June and stream discharge generally decreased thereafter until base flow was attained in September or October.

Notable differences in discharge patterns at sites 1H, 3, and 4 included: 1) lower maxima in 1979, at most, 50% of 1978 values, 2) sharply lower diel variation of discharge in 1979, and 3) the occurrence of two significant precipitation related discharge pulses in 1979 compared with none in 1978.

The lower maxima values at sites 1H, 3, and 4 could have resulted from several factors. Samples were collected on 13-14 and 18-19 June, 1979, while peak runoff discharge probably occurred on 15 June, as indicated from site 2GS (fig. 3). In addition, peak runoff discharges were apparently lower in 1979. Maximum mean daily discharge at site 2GS was only 2.97 m^3/sec in 1979 compared with a value of at least 3.60 m^3/sec in 1978. (The 1978 hydrograph for site 2GS was not begun until late June, possibly after peak runoff. See Cline and Ward (1979).) Finally, total runoff could have been lower in 1979, but there were no data to support or refute this possibility.

Based on field observations, meteorological conditions were believed largely responsible for the lower diel discharge variations in 1979, but documentation and interpretation of these phenomena are beyond the scope of this study.

Total Suspended Solids. Total suspended solids levels were higher below reservoir construction (tables 4-7) even after discharge differences were taken into account (fig. 7). Because discharge values were not available for sites 2DAM and 2, the absolute contributions of snowmelt runoff and reservoir construction could not be partitioned even though samples were taken for this purpose (app. A-B).

For comparable discharges, suspended solids levels at site 3 were at least double those at site 1. Furthermore, as indicated by the slope of the regression line, stability was lower at site 3, i.e., suspended solids transport appeared more energy limited and less materials limited than at site 1. Suspended solids values and system stability were virtually the same at sites 4 and 1. Given the proximity of sites 3 and 4, the intervening North Fork clearly played an ameliorative role by diluting suspended solids levels in the main fork.

The overall patterns of elevated suspended solids below reservoir construction were similar in 1979 and 1978 (Cline and Ward 1979). Furthermore, the suspended solids-discharge relationships for site 1H was virtually identical in 1978 and 1979. On the other hand, the same relationship for sites 3 and 4 were quite different during the two years, presumably because of the variable contribution of suspended solids from reservoir construction.

Suspended solids levels as low as 100 mg/l have been shown to markedly reduce fish presence in streams (Alabaster 1972). However, much lower suspended solids levels can induce similar effects when stream discharge is low enough to allow sedimentation. Gammon (1970) found a reduction in fish

standing crop during times of elevated suspended solids in the spring. He also found that during summer, fish moved into pools during periods of high suspended solids and that they moved out of pools only after deposition had occurred. Macroinvertebrate densities decreased 40% at only 40 mg/l and 60% at 120 mg/l. Similar results were reported in reviews by Cordone and Kelley (1961) and Sorensen et al. (1977).

The organic portion of total suspended solids also increased downstream from reservoir construction (table 8). Samples from site 2 were consistently two to thirty times higher than at site 1, especially in May when snowmelt runoff commenced. Values tended to decline progressively at sites farther downstream, indicative of the ameliorative role of diluting tributaries. Samples collected during 1979 were lower in total organic matter content, but differences among sites were greater than in 1978; thus, a construction effect was evident in 1979, contrary to results of the 1978 study (Cline et al. 1979).

Total Dissolved Solids. Neither total dissolved solids nor the organic portion appeared were significantly affected by reservoir construction (tables 9-10). Values were relatively similar among sites on any particular date in 1979, just as in 1978 (Cline et al. 1979).

pH. Values for pH ranged from 6.9 to 7.3 (table 11), however, no significant changes were detected as a result of reservoir construction. The range of pH values was greater in 1978, 6.8 to 7.7 (Cline et al. 1979), but there was no apparent significance in this change.

Dissolved Oxygen. Dissolved oxygen values ranged from 92% to 100% of saturation (tables 12-13), thus, there was no apparent effect from reservoir construction. A similar conclusion was made in 1978 (Cline et al. 1979).

Hardness (Bound Carbon Dioxide; $CaCO_3$). Water hardness values did not show any apparent significant effect from reservoir construction in 1979 (table 14) or 1978 (Cline et al. 1979). The lower values in June and July 1979 reflected the contribution of relatively softer water from snowmelt.

Water Temperature. Water temperatures at site 2DAM were characteristic of those found below an impoundment. Thermal minima were higher and maxima lower than at site 1 (tables 15-16). In July, thermal minima were 2° C higher and maxima were comparable to those of site 1 (fig. 8). Later, during 14-20 September for example, the average temperature ranged from 0.5° C to 12.5° C at site 1 while only 6° C to 8° C at site 2DAM. Evidently, when stream discharge was lower at site 1, lower volume replacement rate and greater insolation occurred within the reservoir impoundment to induce more significant thermal alteration at site 2DAM.

At sites 3, 4, and 5, thermal minima tended to be lower while maxima were similar to values at site 2DAM, but no consistent pattern was evident. Site-specific characteristics, such as intervening tributaries and the amount of solar insolation, appeared more influential than any construction related effects.

The water temperature patterns discerned in 1978 (Cline et al. 1979) recurred in 1979. The greatest temperature ranges occurred at site 1 were stream discharge was lowest (see Smith and Lavis 1975). The altered thermal regime found at site 2DAM in 1978 was even more distinct in 1979 but still did not noticeably affect water temperature at sites farther downstream. Ward (1974, 1976b) and Ward and Stanford (1979) reported that even slight thermal alterations may significantly affect stream biota.

Substrate. Substrate composition data (tables 17-18) indicated that fine particle (less than 1.00 mm diameter) deposition was influenced more by discharge regime and stream gradient at each site than by reservoir construction.

In slow water (depositional areas), the percentage of fine particles was lower in July than June because of erosional snowmelt runoff. In August, when stream discharge was declining, the percentage of fine particles increased at sites 1, 4, and 5 while remaining the same at sites 2 and 3.

Fine particles accounted for less than 1.2% of the total weight in fast water (erosional) samples. Because of these low values and the margin for sample variation and measurement error, there were no reliable trends to evaluate.

The trends of substrate fine particle accumulation were similar in 1979 and 1978, with the exception of site 5 where values of less than 0.5% in July and August 1979 were sharply lower than the 7-10% in 1978 (Cline *et al*. 1979).

The accumulation of fine particles can adversely biotic communities by: (1) smothering organisms, (2) reducing food sources, (3) eliminating cryptic fauna, (4) reducing fish spawning areas, and (5) rendering holdfasts useless (Alabaster 1972, Chutter 1969, Cordone and Kelley 1961, Einstein 1972, Gammon 1970, Rosenberg and Wiens 1975, and Saunders and Smith 1965). Fine particle accumulation may also reduce substrate permeability (McNeil and Ahnell 1964) and result in decreased survival of fish larvae (Hall and Lantz 1969).

Mean (geometric) particle size values, d_g, in slow water areas (table 17) increased after peak meltoff except at site 1 (fig. 9), but decreased at all sites in August because of depositional streamflow.

Following peak meltoff, fast water mean (geometric) particle size values (table 18) decreased at sites 1, 3, and 4 but increased at sites 2 and 5.

Substrate mean (geometric) particle size did not display consistent response to reservoir construction, stream discharge, or stream gradient; moreover, the values and trends determined during 1979 bore little resemblance to those of 1978 (Cline and Ward 1979). These results are inexplicable but may be aided by additional sampling in 1980.

Epilithon. Epilithon samples were composed largely of "detritus" (inorganic and dead organic material) at all sites in June (table 19). In July and August, detritus still accounted for 99-100% of samples at site 2, while algae and moss (Bryophyta) accounted for 60-98% of samples from other sites.

Bryophyta predominated at site 1 in July but were replaced largely by *Hydrurus* (Chrysophyta) in August. Chrysophyta predominated at sites 3 and 5 in July and were succeeded largely by Cyanophyta and Chlorophyta, respectively, in August. At site 4, the red algae *Lemanea* and *Audouinella* predominated in July and were replaced by Bacillariophyta in August. Thus, overall algal composition appeared to be site-specific and no definitive conclusion regarding the effects of reservoir construction could be made.

More taxa were found at sites downstream from construction (Site:Total number of taxa; 2:31; 3:45; 4:43; 5:29) than at site 1 (20 taxa) while monthly changes in composition of individual taxa were lowest at site 1 and highest at site 5 (table 20).

Epilithon organic biomass values were comparably low (0.1 - 0.2 g/m^2) at all sites in June (table 21). In July, values increased 24 to 75 times

at sites 1, 3, 4, and 5 while remaining essentially unchanged at site 2. In August, values decreased at most sites and were comparably low at sites 1, 2, and 3 (0.3 g/m^2); values at sites 4 and 5 were somewhat higher, 0.6 and 4.6 g/m^2, respectively.

In 1978, more taxa occurred at downstream sites (Cline et al. 1979), a trend repeated and enhanced in 1979 when 50% more taxa were found. Total biomass values were lower in 1979, but reservoir construction effects were more pronouced at site 2, especially during July when the algal community standing crop was highest. Nonetheless, relatively rapid recovery was evident at sites farther downstream.

Macroinvertebrates. Since macroinvertebrates parameters displayed similar trends in slow water and fast water areas, initial discussion will not delineate faunal differences as a function of substrate type.

Mean total macroinvertebrate density (tables 22-25) and biomass values (tables 26-27) at site 2 were 10-20% of values at site 1; however, almost complete recovery was evident at sites 3-5 where values were comparable to those at site 1. In addition, density and biomass values tended to be higher and construction effects more pronounced in slow water areas than fast water areas.

Percentage composition by density of Ephemeroptera was 15-20% lower at site 2 than site 1, increased at sites 3 and 4, and decreased again at site 5 (tables 28-29). Plecoptera were also relatively less abundant at site 2 than at site 1, and increased in importance at sites 3-5. Diptera percentage composition values, including those of the disturbance-tolerant Chironomidae, were two times higher at sites 2, 3, and 5 than at sites 1

and 4. Coleoptera and Turbellaria decreased while Oligochaeta were higher in relative abundance at site 2 than site 1, but no clear trends were evident farther downstream. Trichoptera, Hydracarina, and Nematoda displayed no consistent longitudinal pattern. Overall, Ephemeroptera were relatively more abundant in fast water areas than slow water areas while Diptera displayed precisely the opposite trend. The combined values for these two orders were marginally lower in slow water areas (62-89%) than fast water areas (72-92%). Other taxa did not display any consistent differences between slow water and fast water areas.

Although biomass percentage composition values did not display any consistent longitudinal trends, Diptera and Ephemeroptera did comprise the majority of total biomass (tables 30-31). Their combined relative abundance accounted for 52-86% of total biomass in slow water and 66-80% in fast water areas. Plecoptera biomass was also a significant component, ranging from 3-38% of total biomass, primarily because of the relatively large mature *Megarcys signata* or smaller *Taenionema* which were abundant in September and October. Only the values for Ephemeroptera were consistently higher in faster water areas than slow water areas.

The total number of taxa found at sites 1, 3, 4, and 5 was about double the number found at site 2 (tables 32-33). This trend was also evident on virtually every date that slow water samples were taken; however, no consistent differences were detected between slow and fast water areas on any date or for the sampling season. In both 1978 and 1979, the number of taxa increased with time (Cline *et al.* 1979), but no other similarities were apparent.

Shannon-Weaver Diversity Index ($\overline{d}$) and equitability index (e) values (tables 34-37) were not comparable for most individual dates because many samples contained an insufficient number of organisms for valid analyses (Weber 1973), especially at site 2 or during runoff at other sites. However, total diversity, computed from the grand total of organisms collected, was highest at site 1, lowest at site 2, and intermediate at sites 3-5. Total diversity values were also higher in fast water areas than slow water areas, except at site 3, but all were characteristic of unpolluted waters (Weber 1973). On the other hand, total equitability values, computed from the grand total of organisms collected, were indicative of construction effects at sites 3 and 5, but none were indicated at sites 1, 2, and 4.

Compared with results obtained in 1978 (Cline et al. 1979), mean total macroinvertebrate density and biomass values were three to four times higher at site 1 and lower or comparable at sites 2-5. Relative abundance by density and biomass of major taxa paralleled findings in 1978, but longitudinal patterns were more defined and some differences between slow and fast water areas were apparent. Diversity index values and the total number of taxa were higher at sites 1 and 3-5 in 1979, but lower at site 2, while equitability values displayed no consistent changes from results obtained in 1978.

Evidence of reservoir construction adversely affecting the macroinvertebrate community was definitive in 1979. Mean total macroinvertebrate density, mean total biomass, total number of taxa, and total diversity values were consistently lower at site 2 than site 1, but increased at sites 3-5. In addition, the more disturbance-tolerant Diptera and Oligochaeta increased

in relative abundance at site 2 while Ephemeroptera and Plecoptera experienced decline; however, reversal of these trends did occur at sites 3-5, indicative of some recovery. Biomass composition data for major taxa displayed no clear trends while equitability values were indicative of perturbation at sites 3 and 5. The high equitability values at site 2 were inexplicable in light of all other aforementioned trends.

Fish. Fish were sampled on 29-30 August and 22-23 September. Cutthroat-rainbow trout hybrids (Salmo clarki x S. gairdneri) were present both upstream and downstream from reservoir construction. The degree of cutthroat-rainbow hybridization varied but tended to show more of the cutthroat features. Even those specimens which appeared to be pure cutthroat trout had to be considered hybrids because of rainbow trout stocking by the Colorado Division of Wildlife.

Younger hybrid trout predominated in the age structure and the average coefficient of condition value, K, of hybrids upstream from construction was higher (1.06) than values for hybrids downstream (1.00) (table 38; fig. 10). Because of high sample variances, these differences were not statistically significant, but values steadily declined at sites 2, 3U, and 3 before increasing at site 4; only one fish was captures at site 5.

The length-weight regression analysis for hybrid trout upstream from construction:

$$\text{Log Weight} = 3.25 (\text{Log Length}) - 5.51$$

$$(r = 0.97;\ N = 34)$$

did not significantly differ ($p > 0.05$) from fish downstream from construction:

$$\text{Log Weight} = 3.06\ (\text{Log Length}) - 5.30$$

$$(r = 0.99;\ N = 45)$$

(Analysis of Covariance); therefore, data were pooled for a single regression equation (fig. 11):

$$\text{Log Weight} = 3.09\ (\text{Log Length}) - 5.19$$

$$(r = 0.98;\ N = 79)$$

The total body length-total scale redius relationship (table 39) for hybrid trout upstream from construction:

$$\text{Total Length} = 3.07\ (\text{Total Scale Radius}) + 34.1$$

$$(r = 0.77;\ N = 34)$$

was not significantly different ($p > 0.05$) for fish downstream from construction:

$$\text{Total Length} = 3.29\ (\text{Total Scale Radius}) + 43.3$$

$$(r = 0.82;\ N = 45).$$

These data were pooled, yielding (fig. 12):

$$\text{Total Length} = 3.24\ (\text{Total Scale Radius}) + 37.5$$

$$(r = 0.78;\ N = 79).$$

Estimated lengths and weights at annulus formation for each age class (tables 40-41) exhibited Lee's phenomenon, i.e., older fish exhibited lower back calculated lengths and weights than younger fish. Population phenomena or sampling bias may account for these results (see Bagenal 1978), but such a determination is beyond the scope of this study.

Stomach contents of nine cutthroat-rainbow hybrids upstreams from construction revealed that terrestrial taxa and immature aquatic insects were

equally important numerically (table 42) and accounted for 96% of the items identified. Adult (aerial) stages of aquatic insects were relatively unimportant. Immature aquatic Diptera, primarily Chironomidae, and terrestrial Lygaeidae (Hemiptera), followed by immature Ephemeroptera and terrestrial Hymenoptera, were the most abundant taxa, accounting for 79% of all items identified. Volumetrically, terrestrial taxa relative abundance values were two times higher than immature aquatic insect values and four times greater than values for adult (aerial) stages of aquatic insects. Further analysis, using Ivlev's Feeding Electivity Index (table 43), revealed that these hybrid trout moderately to strongly avoided feeding on Plecoptera, Trichoptera, and Coleoptera. Ephemeroptera and Diptera were consumed in proportion to their abundance, while Nematoda were strongly selected. Similar analyses were unavailable for fish downstream from contruction because of small sample sizes. Nonetheless, these results underscored the importance of preserving riparian vegetation from which many terrestrial taxa may fall into the stream.

Results for longnose suckers (Catostomus catostomus) are presented for informational purposes only. Possible construction related effects could not be evaluated because these fish were captured only downstream from construction and sample sizes were inadequate for reliable trend analyses. In addition, comparable data are not available from 1978 (Cline et al. 1979).

Fish three years and older predominated in the age structure (table 44), but this phenomenon could be an artifact of sampling since small sized fish are less vulnerable to electroshocking (Edward and Higgins 1973). Condition factors ranged from 0.80 to 1.40, and regression of length versus weight yielded (fig. 13):

$$\text{Log Weight} = 2.95\ (\text{Log Length}) - 4.90$$
$$(r = 0.99;\ N = 24).$$

The total length-total scale radius relationship for longnose suckers was:

$$\text{Total Length} = 2.11\ (\text{Total Scale Radius}) - 77.4$$
$$(r = 0.87;\ N = 24).$$

Unlike results obtained for the hybrid trout, back calculated lengths and weights at annulus formation (tables 46-47) for longnose suckers did not exemplify Lee's phenomenon.

Since only two rainbow trout (S. gairdneri) were captured in 1979 (table 48), data were insufficient for further analyses.

No tagged fish were recovered, precluding standard statistical estimates of fish standing crop. Density estimates were based on the total number of fish captured and seen (table 49). Because sampling was done during times when water was clear and at a low level, moderately high confidence was placed in the visual census. Estimated density was highest at site 1 (12.5 fish per 100 m of stream), lowest at sites 2, 3, and 4, and intermediate at sites 3U and 5.

During 1979, no definitive changes in fish age and growth were detected, but the condition factors of hybrid trout tended to be lower at sites downstream from construction and all mean values tended to be lower than those reported by Carlander (1969). Fish density estimates were two times higher at sites 1, 2, 3U, and 3 while comparable at sites 4 and 5 in 1979, but these differences could not be proven significant. Thus, results of fish sampling were similar in 1979 and 1978 (Cline et al. 1979).

Substrate Permeability. Substrate permeability measurements were made on four occasions in 1979 (table 50). All measurements made on 12 and 29 July, which correspond to the time period in which cutthroat-rainbow trout hybrids began to spawn (Bell 1973, Reiser and Wesche 1977), exceeded instrument or operator capabilities. Therefore, critical minima for hybrid trout egg survival were exceeded greatly (Terhune 1958).

Permeability measurements made on 19 August and 7 September were quantifiable. Some measurements were made purposely in areas of lowest or highest sedimentation. Hall and Lantz (1969), McNeil (1964), and McNeil and Ahnell (1964) reported that fine particle accumulations of 5% to 15% decreased substrate permeability sufficiently to reduce fish egg survival. In this study, some substrate samples contained 6% fine particles, but permeability measurements made in similar areas were 3,000 cm/hr or higher, well above the critical minimum of 100 cm/hr (Wickett 1954) possibly because the overall texture of the substrate was sand (see Buckman and Brady 1969; p. 51). Silt and clay particles, which are more impervious and would decrease substrate permeability, comprised less than 0.4% of total substrate weight.

SUMMARY AND CONCLUSIONS

This report presents the results of the second year of study of some hydrological, physicochemical, and biological parameters of Joe Wright Creek, a high mountain stream subjected to reservoir construction activities in 1979.

Two sites upstream from reservoir construction were selected as control sites. Seven other sites were sampled downstream to detect construction effects on the stream and to evaluate longitudinal recovery.

Reservoir construction activities did not significantly affect stream discharge, organic or inorganic fractions of total dissolved solids, pH, dissolved oxygen, bound carbon dioxide, or substrate permeability.

Results obtained for substrate fine particle accumulation and substrate mean particle size were inconclusive. Site specific differences in stream discharge and gradient precluded detection of consistent trends. Likewise, fish sampling data were inconclusive. Cutthroat-rainbow trout hybrids and longnose suckers generally exhibited condition factor values lower than those reported by other researchers and condition factor values for trout downstream from construction were consistently lower than those for trout upstream, but these differences were not significantly different. Estimated total fish density was also lower downstream from construction, but, again, a definitive relationship could not be established. It was determined, however, that the cutthroat-rainbow hybrids consumed a significant number of terrestrial invertebrates which depended upon the presence of riparian vegetation. Preservation of this habitat appears to be important for normal growth of fish in this stream.

Reservoir construction activities did affect several other parameters. Suspended solids levels increased two to three times in areas downstream from construction, but dilution by intermediate tributaries partially ameliorated these increases. The organic fraction of suspended solids also was elevated downstream from construction, then decreased farther downstream.

Thermal minima increased and maxima decreased in areas immediately below reservoir construction, but these changes were less apparent at sites farther downstream.

Epilithon biomass remained at unusually low levels immediately below the reservoir construction while standing crop at other sites increased 24 to 75 times. Overall epilithon compositional changes were site specific, but the number of taxa and month-to-month changes in species composition increased longitudinally. It is not known whether these compositional changes resulted from reservoir construction.

Macroinvertebrate density and biomass values declined 80-90% at site 2, immediately downstream from construction, but quickly recovered farther downstream. Concurrent changes in composition by density occurred but no effect on biomass composition was noted. The number of taxa and species diversity index values also declined immediately downstream from construction before increasing at sites farther downstream.

The effects of reservoir construction on Joe Wright Creek detected during 1979 generally paralleled those reported for 1978 (Cline et al. 1979) with the exception of the organic fraction of suspended solids which apparently were affected in 1979. Overall, construction effects were more pronounced in 1979, especially in the macroinvertebrate and algal communities; yet, partial to complete recovery did occur farther downstream. As discussed by Cline et al. (1979a), the relatively high stream gradient, scarcity of pools, and ameliorative action of tributaries are believed largely responsible to the higher than expected inertia (ability to resist disturbance) and resilience (ability to recover from disturbance) of Joe Wright Creek. However, it should be noted that some compositional changes occurred in the fauna and flora downstream from reservoir construction and that the measurements made in this study were selective and performed

over a relatively short time period. In addition, long term or sublethal changes may not have been detected using current methods of investigation. As a result, care must be taken when interpreting the findings herein.

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Table 1. Joe Wright Creek field sampling dates and parameters.

	Maximum-minimum thermometers	pH	Hardness	Dissolved oxygen	Suspended solids	Dissolved solids	Epilithon	Macroinvertebrates	Fish	Substrate	Permeability
1979:											
May											
12-13		X	X	X	X	X					
20-21					X						
25-28		X	X	X	X	X					
June											
2-4					X		X		X		
11-14		X			X			X	X		
18-19					X						
25-28		X	X	X	X	X			X		
July											
3	X						X				
10-12	X	X			X				X		X
19-20	X				X			X			
27-29	X	X	X	X	X	X			X		X
August											
1-3	X				X						
10-11	X	X							X		
16-17	X				X						
23-24	X	X		X			X	X	X		
29-30	X		X		X	X				X	X
September											
6-7	X	X			X				X		X
14	X										
21-23	X			X					X	X	
28	X		X		X	X					
October											
4-5	X	X			X				X		
12	X										
19	X										
26	X										

Table 1. (Cont.)

	Maximum-minimum thermometers	pH	Hardness	Dissolved oxygen	Suspended solids	Dissolved solids	Epilithon	Macroinvertebrates	Fish	Substrate	Permeability
1979:											
November											
2	X										
December											
15-16		X	X	X	X	X					
1980:											
February											
2-3		X	X	X	X	X					
March											
14		X	X	X	X	X					
April											
4-5		X	X	X	X	X					

Table 2. Joe Wright Creek mean daily discharge, site 1, 1979 (data from U.S. Geological Survey (1980): Site No. 06746100).

Date	Apr	May	Jun	Jul	Aug	Sep
		Mean daily discharge (m^3/sec)				
1		0.01	0.31	1.19	0.22	0.16
2		0.01	0.34	1.02	0.19	0.15
3		0.01	0.68	0.96	0.18	0.14
4		0.01	0.54	0.91	0.16	0.12
5		0.02	0.59	0.76	0.16	0.12
6		0.02	0.79	0.74	0.15	0.12
7		0.03	0.88	0.71	0.14	0.12
8		0.04	0.62	0.65	0.12	0.09
9		0.05	0.51	0.59	0.11	0.05
10		0.03	0.48	0.62	0.24	0.06
11		0.02	0.59	0.57	0.16	0.06
12		0.02	0.88	0.65	0.14	0.05
13		0.02	1.08	0.74	0.24	0.05
14		0.02	1.44	0.71	0.26	0.06
15		0.07	1.67	0.68	0.27	0.05
16		0.10	1.53	0.65	0.27	0.04
17		0.13	1.44	0.62	0.31	0.04
18		0.17	1.30	0.57	0.40	0.03
19		0.19	1.02	0.51	0.65	0.03
20		0.20	0.93	0.45	0.59	0.04
21		0.20	0.93	0.45	0.51	0.03
22	a	0.21	0.93	0.42	0.40	0.03
23	0.02	0.23	1.05	0.40	0.37	0.03
24	0.02	0.23	1.15	0.48	0.34	0.03
25	0.02	0.23	1.16	0.37	0.31	0.03
26	0.02	0.28	1.19	0.34	0.28	0.04
27	0.02	0.31	1.27	0.31	0.26	0.03
28	0.02	0.96	1.27	0.31	0.23	0.03
29	0.02	0.71	1.27	0.27	0.21	0.03
30	0.01	0.40	1.25	0.25	0.20	0.03
31	-	0.37	-	0.24	0.18	- b

a 1 Jan-22 Apr: $\leq$ 0.01 m^3/sec
b Data not yet available for 1 Oct-31 Dec.

Table 3. Joe Wright Creek mean daily discharge, site 2GS, 1979 (data from U.S. Geological Survey (1980): Site No. 06746110).

	Mean daily discharge (m^3/sec)					
Date	Apr	May	Jun	Jul	Aug	Sep
1		0.02	0.82	2.10	0.37	0.31
2		0.02	0.85	1.87	0.34	0.28
3		0.02	1.08	1.81	0.31	0.28
4		0.03	1.30	1.76	0.28	0.28
5		0.03	1.56	1.50	0.28	0.27
6		0.03	1.84	1.36	0.28	0.26
7		0.04	2.15	1.27	0.28	0.26
8		0.06	1.53	1.19	0.27	0.26
9		0.07	1.25	1.10	0.26	0.26
10		0.06	1.27	1.08	0.40	0.25
11		0.04	1.50	1.02	0.31	0.23
12		0.03	2.01	0.85	0.27	0.22
13		0.12	2.38	1.39	0.48	0.20
14		0.05	2.83	1.10	0.54	0.20
15		0.13	2.97	1.05	0.51	0.19
16	a	0.24	2.58	1.02	0.51	0.18
17	0.02	0.34	2.38	0.99	0.65	0.17
18	0.02	0.54	2.21	0.91	0.76	0.14
19	0.02	0.91	1.87	0.79	1.13	0.14
20	0.02	1.03	1.64	0.71	1.22	0.14
21	0.02	1.02	1.73	0.74	0.91	0.14
22	0.02	0.96	1.84	0.74	0.71	0.13
23	0.02	1.05	1.98	0.62	0.62	0.12
24	0.03	1.13	2.01	0.76	0.62	0.11
25	0.03	1.13	2.07	0.71	0.57	0.11
26	0.03	1.25	2.07	0.57	0.48	0.11
27	0.03	1.27	2.18	0.54	0.45	0.10
28	0.03	1.70	2.21	0.54	0.40	0.09
29	0.03	1.78	2.12	0.45	0.37	0.08
30	0.02	1.30	2.10	0.42	0.37	0.08
31	-	0.99	-	0.40	0.34	- b

a 1 Jan-16 Apr: $\leq$ 0.01 m^3/sec

b Data not yet available for 1 Oct-31 Dec

Table 4. Diel variation of discharge, suspended solids, and suspended solids transport, site 1H, Joe Wright Creek, 1979.

Date	Time	Discharge (m^3/sec)	Total Susp. solids (mg/l)	Susp. solids transport[a] (metric tons/day
20-21 May[b]				
25-26 May[c]	0945	0.39	19.91	0.68
	1550	0.25	15.26	0.33
	2145	0.29	77.52	1.94
	0345	0.42	13.75	0.50
	0955	0.29	5.98	0.15
	(Mean)	(0.33)	(26.48)	(0.72)
27-28 May	1000	0.39	13.41	0.45
	1545	0.34	20.86	0.61
	2145	0.42	10.61	0.39
	0345	0.39	15.05	0.51
	0945	0.49	22.66	0.96
	(Mean)	(0.41)	(16.52)	(0.58)
3-4 Jun	1000	0.25	8.13	0.18
	1545	0.34	45.00	1.31
	2150	0.36	12.98	0.41
	0440	0.31	7.15	0.19
	0945	0.29	5.38	0.13
	(Mean)	(0.31)	(15.73)	(0.44)
11-12 Jun	2200	0.42	6.70	0.25
	0400	0.39	6.28	0.21
	1000	0.36	5.01	0.16
	1600	0.90	89.68	6.98
	2200	0.62	24.00	1.28
	(Mean)	(0.54)	(26.33)	(1.78)
13-14 Jun	0400	0.46	9.40	0.37
	1000	0.46	9.33	0.37
	1600	1.05	26.99	2.44
	2200	0.97	21.19	1.78
	0400	0.66	9.26	0.53
	(Mean)	(0.72)	(15.23)	(1.10)

Table 4. (Cont.).

Date	Time	Discharge (m^3/sec)	Total Susp. solids (mg/l)	Susp. solids transport[a] (metric tons/day
18-19 Jun[d]	2200	0.83	23.28	1.68
	0400	- [e]	-	-
	1000	0.62	15.73	0.84
	1600	0.57	7.38	0.37
	2200	0.53	18.37	0.84
	(Mean)	(0.64)	(16.19)	(0.93)
25-26 Jun	2200	0.77	7.89	0.53
	0400	0.72	5.66	0.35
	1000	0.66	6.75	0.39
	1600	0.83	12.49	0.90
	2200	0.83	108.41	7.82
	(Mean)	(0.76)	(28.24)	(2.00)
27-28 Jun	1600	0.97	22.69	1.90
	2200	0.90	17.92	1.39
	0400	0.83	7.04	0.51
	1000	0.77	10.30	0.69
	1600	0.97	15.00	1.26
	(Mean)	(0.89)	(12.59)	(1.15)
11-12 Jul	1600	0.29	5.17	0.13
	2200	0.36	24.25	0.76
	0400	0.36	12.84	0.40
	1000	0.34	10.25	0.30
	1600	0.49	151.75	6.46
	(Mean)	(0.37)	(40.85)	(1.61)
19-20 Jul	2200	0.34	13.61	0.40
	0400	0.31	10.43	0.28
	1000	0.31	8.77	0.24
	1700	0.29	11.21	0.28
	2200	0.31	- [f]	-
	(Mean)	(0.31)	(11.01)	(0.30)
27-28 Jul	1600	0.21	24.10	0.45
	2200	0.25	13.75	0.30
	0400	0.25	36.92	0.80
	1000	0.23	12.59	0.25
	1645	0.21	13.56	0.25
	(Mean)	(0.23)	(20.18)	(0.41)

Table 4. (Cont.).

Date	Time	Discharge (m^3/sec)	Total Susp. solids (mg/l)	Susp. solids transport[a] (metric tons/day
1-2 Aug	2200	0.16	4.73	0.06
	0400	0.16	5.23	0.07
	1000	0.16	5.02	0.07
	1600	0.15	5.39	0.07
	2200	0.15	5.50	0.07
	(Mean)	(0.16)	(5.17)	(0.07)
16-17 Aug	1000	0.17	6.77	0.10
	0400	0.17	6.91	0.10
	1000	0.17	6.26	0.09
	1600	0.16	5.64	0.08
	2200	0.16	5.36	0.07
	(Mean)	(0.17)	(6.19)	(0.09)
6-7 Sep	1600	0.10	4.51	0.04
	2200	0.10	2.32	0.02
	0400	0.10	3.94	0.03
	1000	0.09	0.40	<0.01
	1600	0.02	2.13	0.02
	(Mean)	(0.08)	(2.66)	(0.02)
4-5 Oct	2200	0.05	5.23	0.02
	0400	0.05	4.08	0.02
	1000	0.05	4.15	0.02
	1600	0.05	4.71	0.02
	2200	0.05	3.45	0.02
	(Mean)	(0.05)	(4.32)	(0.02)

[a]Suspended solids x discharge x time.
[b]Snow and ice covered.
[c]First week (day?) of open channel.
[d]First day of 2-10 hour work shifts on reservoir construction.
[e]Weather conditions precluded travel to sample sites.
[f]Sample broken in transit.

Table 5. Diel variation of discharge, suspended solids, and suspended solids transport, site 3, Joe Wright Creek, 1979.

Date	Time	Discharge (m^3/sec)	Total Susp. solids (mg/l)	Susp. solids transport[a] (metric tons/day
20-21 May[b]	1255	1.53	797.00	105.49
	1845	1.53	290.80	38.49
	2345	1.34	434.37	50.43
	0525	1.34	105.76	12.28
	1250	1.26	111.53	12.13
	(Mean)	(1.40)	(347.89)	(43.76)
25-26 May	1155	1.18	1163.44	118.50
	1755	1.15	369.34	36.55
	2155	1.27	182.07	20.06
	0335	1.24	70.84	7.60
	1205	1.31	430.48	48.69
	(Mean)	(1.03)	(443.23)	(46.30)
27-28 May	1215	1.31	189.83	21.47
	1745	1.45	356.86	44.82
	2155	1.53	213.98	28.32
	0355	1.45	183.82	23.09
	1140	1.70	832.22	122.32
	(Mean)	(1.49)	(355.34)	(48.00)
3-4 Jun	1140	1.21	64.42	6.74
	1720	1.65	373.90	53.54
	2200	1.61	121.83	16.99
	0440	1.41	36.32	4.44
	1130	1.41	141.04	17.26
	(Mean)	(1.46)	(147.50)	(19.79)
11-12 Jun	2210	1.99	120.64	20.75
	0410	1.74	149.41	22.54
	1135	1.57	63.32	8.60
	1730	2.52	293.78	63.97
	2210	2.52	198.86	43.30
	(Mean)	(2.07)	(125.20)	(442.68)
13-14 Jun	0410	2.15	72.69	13.53
	1150	1.94	41.34	6.93
	1715	2.64	155.48	35.68
	2210	2.87	251.88	62.52
	0410	2.72	93.86	22.11
	(Mean)	(2.47)	(123.05)	(28.15)

Table 5. (Cont.).

Date	Time	Discharge (m^3/sec)	Total Susp. solids (mg/l)	Susp. solids transport[a] (metric tons/day
18-19 Jun	2210	2.72	57.05	13.44
	0410[c]	-	-	-
	1125	2.33	45.07	9.07
	1710	2.21	33.40	6.38
	2210	2.04	29.52	5.21
	(Mean)	(2.33)	(41.26)	(8.53)
25-26 Jun	2210	1.27	111.31	12.26
	0410	1.18	18.87	1.92
	1120	1.09	19.56	1.84
	1720	1.27	40.81	4.50
	2210	1.31	60.24	6.81
	(Mean)	(1.22)	(50.16)	(5.27)
27-28 Jun	1710	2.94	45.77	11.66
	2210	3.10	158.04	42.44
	0410	2.58	24.88	5.56
	1135	2.39	20.86	4.31
	1700	2.87	40.90	10.15
	(Mean)	(2.78)	(58.09)	(14.82)
11-12 Jul	1730	1.79	235.56	36.49
	2210	1.15	190.55	18.91
	0420	0.91	14.50	1.14
	1125	1.41	817.44	100.02
	1725	1.57	180.40	24.51
	(Mean)	(1.37)	(287.69)	(36.21)
19-20 Jul	2210	1.49	1040.11	134.11
	0410	1.24	190.46	20.44
	1140	1.18	136.14	13.87
	1750	1.12	78.23	7.56
	2210	1.15	60.07	5.96
	(Mean)	(1.24)	(301.00)	(36.39)
27-28 Jul	1705	1.03	10.44	0.93
	2210	1.03	29.71	2.65
	0410	1.06	21.95	2.01
	1030	1.06	13.22	1.21
	1720	1.01	12.17	1.06
	(Mean)	(1.04)	(17.50)	(1.57)

Table 5. (Cont.).

Date	Time	Discharge (m^3/sec)	Total Susp. solids (mg/l)	Susp. solids transport[a] (metric tons/day
1-2 Aug	2210	0.86	8.07	0.60
	0710	0.86	4.30	0.32
	1110	0.86	4.14	0.31
	1700	0.86	6.87	0.51
	2210	0.82	6.01	0.42
	(Mean)	(0.85)	(5.88)	(0.43)
16-17 Aug	2210	0.91	44.33	3.47
	0410	0.91	45.19	3.54
	1055	0.91	50.30	3.94
	1700	0.86	34.08	2.53
	2200	0.86	32.26	2.40
	(Mean)	(0.89)	(41.23)	(3.18)
6-7 Sep	1650	0.72	35.14	2.18
	2210	0.72	37.80	2.34
	0410	0.73	8.24	0.52
	1050	0.73	13.46	0.86
	1650	0.72	71.00	4.40
	(Mean)	(0.72)	(33.13)	(2.06)
4-5 Oct	2210	0.58	41.77	2.10
	0410	0.58	38.05	1.91
	1050	0.58	79.60	4.00
	1625	0.58	26.21	1.32
	2210	0.58	12.68	0.64
	(Mean)	(0.58)	(39.66)	(1.99)

[a]Suspended solids x discharge x time.
[b]Discharge may be an overestimate because of ice and snow at stream margins.
[c]Weather conditions precluded travel to sample sites.

Table 6. Diel variation of discharge, suspended solids, and suspended solids transport, site 4, Joe Wright Creek, 1979.

Date	Time	Discharge (m^3/sec)	Total Susp. solids (mg/l)	Susp. solids transport[a] (metric tons/day
20-21 May[b]	1330	2.17	172.97	32.52
	1915	2.17	165.92	31.20
	2355	1.88	80.43	13.08
	0535	1.88	91.76	14.92
	1320	1.75	426.92	64.58
	(Mean)	(1.97)	(187.60)	(31.26)
25-26 May	1250	2.17	131.46	24.72
	1820	2.34	213.02	43.06
	2205	2.34	143.23	28.95
	0405	2.17	61.69	11.60
	1235	2.51	331.07	71.96
	(Mean)	(2.31)	(176.09)	(36.06)
27-28 May	1300	2.70	243.51	56.91
	1815	2.90	240.61	60.46
	2205	2.90	197.61	49.65
	0405	2.70	97.47	22.78
	1210	3.12	679.89	183.68
	(Mean)	(2.86)	(291.22)	(74.70)
3-4 Jun	1205[c]	0.51[c]	45.88[c]	-
	1750	2.51	298.43	64.86
	2220	2.51	94.92	20.63
	0450	2.02	37.53	6.56
	1155	2.51	94.74	20.59
	(Mean)	(2.39)	(131.41)	(28.16)
11-12 Jun	2220	4.17	94.41	34.09
	0420	3.61	88.56	27.66
	1205	2.70	54.67	12.78
	1800	5.58	308.44	148.83
	2220	5.58	190.90	92.11
	(Mean)	(4.33)	(147.40)	(63.09)
13-14 Jun	0420	5.19	84.51	37.93
	1215	4.82	30.74	12.83
	1725	5.58	197.58	95.34
	2220	6.93	262.64	157.52
	0420	5.58	90.47	43.65
	(Mean)	(5.62)	(133.19)	(69.45)

Table 6. (Cont.).

Date	Time	Discharge (m^3/sec)	Total Susp. solids (mg/l)	Susp. solids transport[a] (metric tons/day
18-19	2220	5.99	29.06	15.08
Jun	0420[d]	-	-	-
	1145	4.82	43.85	18.30
	1720	4.49	29.77	11.56
	2220	4.49	29.97	11.63
	(Mean)	(4.95)	(33.16)	(14.14)
25-26	2220	6.45	88.26	49.23
Jun	0420	5.58	19.80	9.55
	1155	4.82	36.80	15.36
	1730	6.45	46.08	25.70
	2220	6.93	70.57	42.32
	(Mean)	(6.05)	(52.30)	(28.43)
27-28	1720	6.93	55.27	33.15
Jun	2220	6.93	127.77	76.63
	0420	5.99	25.94	13.46
	1155	5.58	31.03	14.97
	1710	8.01	48.05	33.31
	(Mean)	(6.69)	(57.61)	(34.30)
11-12	1755	3.36	144.37	41.94
Jul	2220	2.17	128.47	24.15
	0420	1.88	11.36	1.85
	1155	2.51	379.96	82.59
	1750	2.90	110.10	27.66
	(Mean)	(2.56)	(154.85)	(35.64)
19-20	2220	2.51	870.96	189.31
Jul	0420	1.88	159.29	25.91
	1200	1.88	93.13	15.15
	1800	1.88	65.14	10.59
	2220	1.88	39.00	6.34
	(Mean)	(2.01)	(245.50)	(49.46)
27-28	1730	6.45	12.55	7.00
Jul	2220	1.75	25.49	3.86
	0420	1.75	10.98	1.66
	1040	1.63	10.52	1.48
	1730	1.63	15.28	2.15
	(Mean)	(2.64)	(14.96)	(3.23)

Table 6. (Cont.).

Date	Time	Discharge (m^3/sec)	Total Susp. solids (mg/l)	Susp. solids transport[a] (metric tons/day
1-2	2220	1.31	8.35	0.95
Aug	0420	1.31	6.41	0.73
	1125	1.31	7.23	0.82
	1710	1.31	7.63	0.86
	2220	1.31	8.56	0.97
	(Mean)	(1.31)	(7.64)	(0.87)
16-17	2220	1.41	31.35	3.82
Aug	0420	1.41	30.95	3.77
	1105	1.41	30.75	3.74
	1715	1.41	28.16	3.43
	2220	1.41	32.61	3.97
	(Mean)	(1.41)	(30.76)	(3.75)
6-7	1655	0.98	20.18	1.71
Sep	2220	0.98	13.78	1.17
	0420	0.98	7.25	0.61
	1055	0.98	11.57	0.98
	1655	0.98	7.55	0.64
	(Mean)	(0.98)	(12.07)	(1.02)
4-5	2220	0.73	26.86	1.70
Oct	0420	0.73	28.45	1.80
	1055	0.73	16.65	1.06
	1630	0.73	21.94	1.39
	2230	0.73	8.48	0.54
	(Mean)	(0.73)	(20.48)	(1.30)

[a]Suspended solids x discharge x time.
[b]Discharge may be an overestimate because of snow and ice at stream margins.
[c]Discharge measurement probably erroneous; these values not used in mean values.
[d]Weather conditions precluded travel to sample sites.

Table 7. Total suspended solids (mg/l), Joe Wright Creek.

Date	Site 1	2	3	4	5
1979:					
27 May	1.0	30.0	29.2	26.9	16.4
28 June	5.5	24.0	19.0	18.6	18.6
27 July	5.1	51.4	29.4	32.4	4.2
29 August	1.4	53.6	13.0	10.8	7.2
28 September	5.1	42.4	12.1	7.4	4.9
15-16 December	0.7	3.2	3.2	4.4	1.2
1980:					
2-3 February	1.7	—[a]	2.0	0.7	1.7
14 March	—[a]	2.5	1.4	0.5	0.2
4-5 April	—[a]	—[b]	1.5	1.5	2.3
Grand mean	2.9	29.6	12.3	11.5	6.3

[a]Site not sampled.
[b]No running water found. It was later determined that there was negligible outflow from the reservoir.

Table 8. Loss-on-ignition (mg/l), total suspended solids, Joe Wright Creek.

Date	Site 1	2	3	4	5
1979:					
27 May	1.0	30.0	29.2	26.9	16.4
28 June	1.2	2.4	3.3	2.3	2.3
27 July	0.0	3.3	1.3	2.5	0.1
29 August	0.1	2.5	2.3	2.1	1.2
28 September	1.6	7.2	2.4	2.2	2.3
15-16 December	0.1	1.8	1.4	0.5	0.3
1980:					
2-3 February	1.6	—[a]	1.1	0.1	1.0
14 March	—[a]	1.5	0.9	0.4	0.1
4-5 April	—[a]	—[b]	0.1	0.4	1.3
Grand mean	0.8	6.9	4.7	4.2	2.8

[a]Site not sampled.
[b]No running water found. It was later determined that there was negligible outflow from the reservoir.

Table 9 . Total dissolved solids (mg/l), Joe Wright Creek.

Date/Site	1	2	3	4	5
1979:					
12-13 May	a	43.5	36.4	35.5	32.6
27 May	27.5	22.3	23.3	27.7	29.2
28 Jun	17.5	17.0	17.9	20.5	16.8
27 Jul	18.2	17.6	20.4	23.2	22.8
29 Aug	19.0	38.2	30.3	22.5	23.6
28 Sep	37.3	29.2	35.7	32.3	29.5
15-16 Dec	31.9	31.6	27.8	39.6	27.6
1980:					
2-3 Feb	22.4	a	30.5	26.0	24.5
14 Mar	a	29.1	34.6	20.0	31.8
4-5 Apr	a	b	31.7	30.3	22.2
(Mean value)	(24.8)	(28.6)	(28.9)	(27.8)	(26.1)

[a]Not sampled.
[b]No apparent water flow.

Table 10. Organic portion of total dissolved solids (mg/l), Joe Wright Creek.

Date/Site	1	2	3	4	5
1979:					
12-13 May	a	15.9	11.9	11.5	11.3
27 May	11.7	10.4	10.3	11.0	14.7
28 Jun	7.2	7.4	7.2	7.9	7.5
27 Jul	6.2	6.4	6.5	7.5	16.0
29 Aug	5.4	11.5	8.8	7.3	6.5
28 Sep	10.9	9.8	10.4	9.8	23.1
15-16 Dec	9.7	10.2	8.6	11.4	8.4
1980:					
2-3 Feb	7.4	a	6.9	7.3	7.7
14 Mar	a	8.6	8.7	5.3	9.8
4-5 Apr	a	b	8.1	9.3	5.2
(Mean value)	(8.4)	(10.0)	(8.7)	(8.8)	(11.0)

[a]Not sampled.
[b]No apparent water flow.

Table 11. Joe Wright Creek pH values.

Date/Site	1	2	3	4	5
1979:					
12-13 May	a	7.2	7.2	7.2	7.3
27 May	7.0	7.0	7.0	7.2	7.2
14 Jun	7.1	7.1	7.1	7.1	7.2
27-28 Jun	7.1	7.2	7.1	7.0	6.9
11-12 Jul	7.2	7.2	7.2	7.2	7.2
27 Jul	7.3	7.2	7.3	7.3	7.3
10 Aug	7.1	7.3	7.2	7.2	7.2
23 Aug	7.2	7.2	7.2	7.2	7.2
6 Sep	7.1	7.1	7.1	7.1	7.2
5 Oct	7.1	7.2	7.1	7.1	7.1
15-16 Dec	7.2	7.2	7.3	7.3	7.3
1980:					
2-3 Feb	7.1	a	7.1	7.1	7.2
14 Mar	a	7.3	7.2	7.2	7.2
4-5 Apr	a	b	7.1	7.3	7.3
(Mode)	(7.2)	(7.2)	(7.2)	(7.2)	(7.1)

[a]Not sampled.
[b]No apparent water flow.

Table 12. Dissolved oxygen (mg/l), Joe Wright Creek.

Date/Site	1	2	3	4	5
1979:					
12-13 May	a	9.5	9.5	9.6	9.9
27 May	10.4	10.1	9.5	10.0	9.6
28 Jun	9.0	9.0	9.0	9.7	9.8
27 Jul	7.0	7.3	8.0	8.5	9.0
23 Aug	9.1	8.6	8.5	8.3	8.4
21 Sep	8.1	8.9	8.9	9.2	9.2
15-16 Dec	10.4	10.3	10.3	10.1	10.1
1980:					
2-3 Feb	10.2	a	9.8	9.9	10.0
14 Mar	a	9.9	10.2	9.6	10.7
4-5 Apr	a	b	10.4	10.3	10.8
(Mean value)	(9.2)	(9.2)	(9.4)	(9.5)	(9.8)

[a]Not sampled.
[b]No apparent water flow.

Table 13. Percentage saturation of dissolved oxygen, Joe Wright Creek.

Date/Site	1	2	3	4	5
1979:					
12-13 May	a	92	92	93	95
27 May	100	98	92	97	93
28 Jun	97	100	99	100	100
27 Jul	94	94	95	100	100
23 Aug	100	98	99	96	100
21 Sep	100	100	100	96	96
15-16 Dec	100	100	99	97	97
1980:					
2-3 Feb	99	a	95	96	96
14 Mar	a	96	98	93	100
4-5 Apr	a	b	100	99	100
(Mean value)	(99)	(98)	(97)	(97)	(98)

[a]Not sampled.
[b]No apparent water flow.

Table 14. Bound carbon dioxide (i.e., $CaCO_3$)(ppm), Joe Wright Creek.

Date/Site	1	2	3	4	5
1979:					
12-13 May	a	6.0	5.5	6.5	6.5
27 May	5.5	6.0	6.0	6.5	7.0
28 Jun	6.0	6.0	6.5	6.5	7.0
27 Jul	7.5	8.0	8.0	9.0	9.5
29 Aug	10.0	10.5	12.0	12.5	14.0
28 Sep	14.0	14.5	15.0	15.5	15.5
15-16 Dec	14.0	14.5	15.0	15.5	15.5
1980:					
2-3 Feb	11.5	a	10.3	13.0	11.5
14 Mar	a	8.0	10.5	12.0	10.5
4-5 Apr	a	b	9.0	12.0	11.0
(Mean value)	(9.8)	(9.2)	(9.8)	(10.9)	(10.8)

[a]Not sampled.
[b]No apparent water flow.

Table 15. Minimum water temperature (°C) during previous week, Joe Wright Creek, 1979.

Date/Site	1	2DAM	3	4	5
3 Jul	--------------------equipment installed--------------------				
10 Jul	0.2	3.0	2.4	1.7	4.7
20 Jul	0.7	4.0	2.9	2.8	2.7
27 Jul	2.4	6.0	4.4	7.3	4.7
3 Aug	2.4	5.5	4.9	6.2	4.7
10 Aug	2.4	6.0	5.4	4.0	3.7
17 Aug	2.4	6.5	6.4	6.2	5.2
24 Aug	1.3	4.5	0.0	4.0	2.7
30 Aug	0.2	3.5	3.9	2.8	1.7
7 Sep	0.2	a	4.9	2.8	4.7
14 Sep	0.2	0.5	2.4	1.7	1.2
21 Sep	2.2	2.5	1.4	0.0	0.0
28 Sep	0.0	4.5	3.9	0.6	0.0
5 Oct	0.0	2.5	0.4	2.8	0.0
12 Oct	2.4	1.5	1.4	2.8	0.0
19 Oct	2.4	1.5	0.9	2.8	0.0
26 Oct	0.0	0.0	0.4	0.6	0.0
2 Nov	0.0	0.0	0.0	0.0	0.0
(Mean value)	(1.0)	(3.3)	(2.7)	(2.9)	(2.1)

[a]Air exposed, no data available.

Table 16. Maximum water temperature (°C) during previous week, Joe Wright Creek, 1979.

Date/Site	1	2DAM	3	4	5
3 Jul	-------------------	equipment	installed	-------------------	
10 Jul	a	11.7	9.5	10.4	11.2
20 Jul	13.8	16.6	13.0	9.5	24.8
27 Jul	14.6	12.2	13.0	10.4	18.5
3 Aug	15.5	14.4	13.5	13.2	14.4
10 Aug	17.2	14.8	13.0	14.2	10.2
17 Aug	16.4	11.3	13.0	10.0	11.2
24 Aug	13.8	9.5	15.1	14.2	10.2
30 Aug	13.8	12.2	11.0	11.4	11.2
7 Sep	11.2	b	11.0	12.3	11.2
14 Sep	a	13.0	12.0	12.3	12.3
21 Sep	a	9.9	12.5	10.4	a
28 Sep	a	8.6	8.9	10.0	10.2
5 Oct	12.9	7.7	7.9	9.5	7.0
12 Oct	a	7.7	7.9	8.6	7.0
19 Oct	11.2	5.9	6.9	7.7	6.0
26 Oct	a	5.5	4.9	5.8	4.9
2 Nov	0.0	0.0	0.0	0.0	0,0
(Mean value)	(12.8)	(10.1)	(10.2)	(10.0)	(10.6)

[a]Mercury separated. No reliable data available.
[b]Air exposed.

Table 17. Substrate cumulative percentage composition and mean (geometric) particle size, dg, slow water areas, Joe Wright Creek, 1979.

			Site		
Size class (mm)	1	2	3	4	5
			Date		
	2 Jun	2 Jun	2 Jun	3 Jun	3 Jun
>50.8	100.0	100.0	100.0	100.0	-
25.4-50.8	53.4	88.1	80.5	50.5	100.0
12.7-25.4	33.6	45.2	31.8	30.6	65.7
5.16-12.7	22.3	29.1	17.0	12.6	39.3
3.35-5.16	12.1	18.5	7.9	4.5	21.0
2.0-3.35	8.9	14.8	6.0	3.0	16.0
1.0-2.0	4.6	8.6	4.0	1.5	9.7
0.05-1.0[a]	2.8	5.2	2.9	0.8	6.4
0.002-0.05[a]	0.0	0.1	0.1	<0.1	0.2
<0.002[a]	0.1	0.1	0.1	<0.1	0.3
dg(mm)[b]	13.0	7.4	11.7	15.9	7.3
	11 Jul	11 Jul	11 Jul	12 Jul	12 Jul
>50.8	100.0	100.0	100.0	100.0	100.0
25.4-50.8	38.8	74.2	66.8	40.6	42.3
12.7-25.4	19.4	42.5	24.8	21.3	17.9
5.6-12.7	9.8	26.7	14.2	9.5	10.0
3.35-5.16	4.2	13.9	6.4	4.6	3.8
2.0-33.5	2.9	10.0	4.9	3.4	2.5
1.0-2.0[a]	1.3	4.7	2.9	1.7	1.1
0.05-1.0[a]	0.8	2.5	1.7	1.0	0.7
0.002-0.05[a]	<0.1	<0.1	<0.1	<0.1	<0.1
<0.002[a]	<0.1	0.1	0.1	<0.1	<0.1
dg(mm)[b]	20.3	9.9	11.6	17.6	20.3
	23 Aug	23 Aug	23 Aug	23 Aug	23 Aug
>50.8	100.0	100.0	100.0	100.0	100.0
25.4-50.8	54.4	93.2	74.1	64.1	42.7
12.7-25.4	37.4	47.3	37.9	39.8	31.7
5.16-12.7	22.8	24.3	19.4	19.4	20.4
3.35-5.16	14.1	10.7	8.4	10.9	11.0
2.0-3.35	11.4	7.4	6.1	8.7	8.6
1.0-2.0	7.3	3.4	2.9	6.4	4.7
0.05-1.0[a]	4.8	2.0	1.6	5.2	2.9
0.002-0[a]05	0.1	<0.1	<0.1	0.1	<0.1
<0.002[a]	0.2	0.1	<0.1	0.1	<0.1
dg(mm)[b]	12.6	9.5	11.0	12.8	13.6

[a]Determined by Soil Testing Laboratory, Colorado State University, using hydrometer method.
[b]Geometric mean, computed following procedure of Platts _et al_. (1979).

Table 18. Substrate cumulative percentage composition and mean (geometric) particle size, dg, fast water areas, Joe Wright Creek, 1979.

Size class (mm)	Site 1	Site 2	Site 3	Site 4	Site 5
	Date				
	2 Jun	2 Jun	2 Jun	3 Jun	3 Jun
>50.8	100.0	100.0	100.0	100.0	100.0
25.4-50.8	35.9	55.5	44.0	30.9	31.8
12.7-25.4	17.4	35.0	19.5	4.0	12.7
5.16-12.7	9.0	21.8	6.2	0.9	5.5
3.35-5.16	4.5	11.3	2.3	0.2	2.4
2.0-3.35	3.2	7.6	1.7	0.1	1.8
1.0-2.0	1.5	2.6	0.8	0.1	0.7
0.05-1.0[a]	1.0	1.2	0.3		0.4
0.002-0.05[a]	<0.1	<0.1	<0.1	0.1	<0.1
<0.002[a]	<0.1	0.1	<0.1		<0.1
dg(mm)[b]	23.0	13.0	20.3	29.3	26.7
	11 Jul	11 Jul	11 Jul	12 Jul	12 Jul
>50.8	100.0	100.0	100.0	100.0	100.0
25.4-50.8	46.6	28.7	51.5	24.2	19.9
12.7-25.4	18.8	10.2	21.5	9.4	7.7
5.16-12.7	12.3	2.5	9.2	4.0	3.0
3.35-5.16	6.8	0.1	3.6	1.0	0.8
2.0-3.35	4.6	0.1	2.0	0.8	0.4
1.0-2.0	1.9	0.1	1.1	0.7	0.2
0.05-1.0[a]	1.0		0.5	0.6	
0.002-0.05[a]	<0.1	0.1	<0.1	<0.1	0.1
<0.002[a]	<0.1		<0.1	<0.1	
dg(mm)[b]	18.3	25.5	18.5	28.5	31.0
	23 Aug	23 Aug	23 Aug	23 Aug	23 Aug
>50.8	100.0	100.0	100.0	100.0	100.0
25.4-50.8	29.3	39.7	52.4	24.3	42.5
12.7-25.4	11.1	16.8	25.6	13.8	18.7
5.16-12.7	7.1	8.0	13.5	4.6	6.6
3.35-5.16	3.4	2.8	6.1	2.0	2.1
2.0-3.35	2.4	1.8	4.2	1.6	1.4
1.0-2.0	1.0	0.7	1.9	1.1	0.5
0.05-1.0[a]	0.6	0.4	0.9	1.0	
0.002-0.05[a]	<0.1	<0.1	<0.1	<0.1	0.4
<0.002[a]	<0.1	<0.1	<0.1	<0.1	
dg(mm)[b]	25.7	23.2	15.7	26.0	19.5

[a]Determined by Soil Testing Laboratory, Colorado State University, using hydrometer method. If only one weight is given for the three categories, there was insufficient sample weight for analysis.

[b]Geometric mean, computed following procedure of Platts _et al_. (1979).

Table 19. Percentage composition of predominant taxa in epilithon samples (10 x 6 cm^2 = 60 cm^2), Joe Wright Creek, 1979.

Date and Taxon	Category (% of Total)					Division (% of Category)					Genus or Species (% of Division)				
Site:	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
14 June:															
"DETRITUS"	98	60	90	99	100										
ALGAE	2	40	10	<1	0										
Bacillariophyta						a	100	20	a						
Achnanthes lanceolata												39	12		
Achnanthes minutissima													10		
Fragilaria vaucheriae												16			
Meridion circulare													11		
Nitzschia dissipata												10			
Chlorophyta						a	a								
Chrysophyta															
Cyanophyta								80	a						
20 July:															
"DETRITUS"	6	100	10	2	5										
BRYOPHYTA	90	0	0	0	0										
ALGAE	4	0	90	98	85										
Bacillariophyta						100	11	5	11						
Diatoma hielmale var. mesodon														30	
Fragilaria vaucheriae														20	
Gomphonema spp.											63		25		
G. olivaceum															64

Table 19. (Cont.)

Date and Taxon	Category (% of Total) Site: 1	2	3	4	5	Division (% of Category) 1	2	3	4	5	Genus or Species (% of Division) 1	2	3	4	5
20 July (Cont.):															
Hannea arcus											20		30	36	14
Nitaschia dissipata															
N. fonticola													26		
Chrysophyta								83		89					
Cyanophyta								6	3	a					
Tolypothrix														98	
Rhodophyta									92						
Lemanea fucina														5	
Audouinella violaceae														95	
23 August:															
"DETRITUS"	40	99	25	30	5										
ALGAE	60	<1	75	70	95										
Bacillariophyta						a	a	7	86	16					
Fragilaria vaucheriae													27		
Gomphonema olivaceum														50	26
Hannea arcus														25	40
Nitzschia dissipata													20		
Chlorophyta									14	84					
Ulothrix															100
Tribonema or Microspora															a
Chrysophyta						100		a							
Hydrurus											100				
Cyanophyta						a	a	93	a						

[a]Present; less than 1%.

Table 20. Common epilithic algae found in Joe Wright Creek, 1979.

Species	14 June					20 July					23 August				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
DIVISION BACILLARIOPHYTA															
Achnanthes affinis			+												
Achnanthes clevei								+							
Achnanthes exigua			+						+						
Achnanthes lanceolata	+	+	+	+		+		+	+	+	+	+	+	+	
Achnanthes lanceolata var. dubia								+							
Achnanthes marginulata									+						
Achnanthes microcephalum				+				+	+						
Achnanthes minutissima	+	+	+	+		+		+	+	+	+	+	+	+	+
Achnanthes peragalli															+
Amphora ovalis		+										+			
Anomoeoneis vitrea															+
Caloneis ventricosa								+							
Cocconeis placentula		+	+	+				+				+	+	+	+
Cyclotella sp.														+	
Cyclotella meneghiniana			+	+											
Cyclotella striata var. bipunctata									+						
Cymbella minuta	+	+	+	+		+		+	+	+	+	+	+	+	+
Cymbella prostrata		+							+			+			
Cymbella sinuata	+	+	+	+		+		+	+	+	+	+	+		
Cymbella sinuata f. antiqua		+						+				+			
Diatoma anceps	+							+	+						
Diatoma hiemale			+												
Diatoma hiemale var. mesodon		+	+	+		+		+	+			+		+	+
Diatoma tenue			+												
Diatoma tenue var. elongatur				+											
Diatoma vulgare		+		+								+			
Diploneis elliptica								+							
Epithemia sorex			+												
Eunotia pectinalis			+												
Fragilaria capucina	+	+	+	+		+		+	+	+	+	+	+		
Fragilaria crotonensis								+					+		+
Fragilaria pinnata	+					+			+		+				+
Fragilaria vaucheriae	+	+	+	+		+		+	+	+	+	+	+	+	+
Frustulia rhomboides	+	+		+		+		+			+	+		+	
Gomphonema acuminatum			+							+					

Table 20. (Cont.)

Species	14 June 1	2	3	4	5	20 July 1	2	3	4	5	23 August 1	2	3	4	5
DIVISION BACILLARIOPHYTA (Cont.)															
Gomphonema intricatum								+							+
Gomphonema olivaceum	+		+	+		+		+	+	+	+	+	+	+	+
Gomphonema rhombicum								+							
Gomphonema truncatum													+		
Hannea arcus	+	+	+			+		+	+	+	+	+	+	+	+
Melosira sp.			+	+											
Melosira italica		+							+			+			
Melosira varians		+										+			
Meridion circulare			+	+					+						
Navicula arvensis				+									+		
Navicula canalis		+										+			+
Navicula cryptocephala		+	+					+	+	+		+			
Navicula exigua			+												
Navicula exigua var. capitata		+		+								+	+	+	
Navicula lanceolata				+											
Navicula minima													+		
Navicula paucivisitata														+	
Navicula pelliculosa			+										+	+	
Navicula pupula			+	+											
Navicula pupula var. elliptica								+							
Navicula radiosa															+
Navicula rhynchocephala		+		+				+				+	+		
Navicula secreta var. apiculata									+						
Navicula secura									+						
Navicula viridula	+								+					+	
Neidium sp.			+	+											
Neidium affine								+							
Nitzschia acicularis	+					+					+				
Nitzschia amphibia									+				+		
Nitzschia dissipata	+	+	+	+	+	+		+	+	+	+	+	+	+	
Nitzschia fonticola	+	+	+	+		+		+	+	+	+	+	+	+	
Nitzschia hungarica			+												
Nitzschia linearis		+	+									+			
Nitzschia palea	+	+		+		+		+		+	+	+	+	+	
Pinnularia sp.		+		+					+			+			

Table 20. (Cont.)

Species	14 June 1	2	3	4	5	20 July 1	2	3	4	5	23 August 1	2	3	4	5
DIVISION BACILLARIOPHYTA (Cont.)															
Pinnularia divergentissima								+							+
Pinnularia intermedia				+											+
Pinnularia mesolepta			+	+				+							+
Rhopalodia gibberula			+												
Rhoicosphenia curvata	+	+	+						+			+	+		
Stauroneis smithii				+											
Surirella angustata		+										+			
Synedra rumpens										+					
Synedra ulna	+			+		+					+	+	+		
Tabellaria fenestrata		+	+									+			
Tabellaria flocculosa	+			+											
DIVISION CHLOROPHYTA															
Closterium sp.														+	
Green coccoid								+							
Ulothrix sp.									+					+	+
DIVISION CHRYSOPHYTA															
Hydrurus foetidus	+	+				+		+		+	+	+	+		
DIVISION CYANOPHYTA															
Dactylococcopsis raphidioides				+											
Oscillatoria sp.								+	+	+					+
Phormidium sp.			+							+	+	+			
Tolypothrix sp.									+						
DIVISION RHODOPHYTA															
Audouinella violaceae									+						
Lemanea fucina (prostrate form)			+												
Lemanea fucina (prostrate form, chantransia, young gametophytes)									+						
DIVISION CHLOROPHYTA OR CHRYROPHYTA															
Microspora sp. or Tribonema sp.															+

Table 21. Inorganic and organic mass of epilithon samples (60 cm^2), Joe Wright Creek, 1979.

	Total mass (g/m^2)	Inorganic portion (g/m^2)	Organic portion ($g/1m^2$)	Percentage Inorganic	Percentage Organic
Site 1					
14 June	0.8	0.7	0.1	91.1	8.9
20 July	5.8	3.4	2.4	58.8	41.2
23 August	1.1	0.8	0.3	73.4	26.6
Site 2					
14 June	1.1	1.0	0.1	93.7	6.3
20 July	1.6	1.4	0.2	87.6	12.4
23 August	3.7	3.4	0.3	92.3	7.7
Site 3					
14 June	0.6	0.5	0.1	78.4	21.6
20 July	10.1	2.6	7.5	25.5	74.5
23 August	1.7	1.4	0.3	80.6	19.4
Site 4					
14 June	1.4	1.3	0.1	91.4	8.6
20 July	20.8	16.3	4.5	78.2	21.8
23 August	14.2	13.6	0.6	95.9	4.1
Site 5					
14 June	1.1	0.9	0.2	81.0	19.0
20 July	114.3	104.1	10.2	91.1	8.9
23 August	55.1	50.3	4.8	91.3	8.7

Table 22. Joe Wright Creek macroinvertebrate taxa and mean total density (organisms/m^2) from 50 core samples in slow water areas at each site, June to October, 1979.

Taxon	Site 1	Site 2	Site 3	Site 4	Site 5
EPHEMEROPTERA	527.3	24.3	236.6	371.6	278.5
Baetidae					
Baetis bicaudatus	55.8	5.5	38.2	55.8	81.8
B. tricaudatus	18.0	0.0	9.2	9.2	0.8
Pseudocloeon sp.	0.4	0.0	2.5	0.0	7.1
Ephemerellidae					
Ephemerella coloradensis	17.2	0.0	2.5	8.4	3.4
E. doddsi	36.9	0.0	1.3	3.4	8.8
E. infrequens	17.6	0.0	1.7	4.6	8.4
Heptageniidae					
Cinyqmula sp.	143.0	7.1	39.8	62.5	52.0
Epeorus deceptivus	75.5	5.1	89.3	66.7	57.5
Rhithrogena sp.	114.1	11.7	49.5	156.0	57.5
Leptophlebiidae					
Paraleptophlebia sp.	6.7	0.0	0.0	0.0	0.0
Siphlonuridae					
Ameletus sp.	41.9	0.8	2.5	5.0	1.3
PLECOPTERA	206.8	1.3	61.2	134.6	245.8
Capniidae					
Capnia sp.	15.1	0.0	1.7	2.5	9.7
Chloroperlidae					
indet.[a]	63.8	0.0	7.6	21.0	36.9
Nemouridae					
Podmosta sp.	5.5	0.0	0.0	2.1	0.0
Zapada cinctipes	0.8	0.0	0.4	0.0	0.4
Z. haysi	26.4	1.3	36.9	47.8	29.8
Perlodidae					
Isoperla sp.	4.2	0.0	2.1	2.1	2.9
Megarcys signata	8.4	0.0	8.4	8.8	7.1
Taeniopterygidae					
Taenionema sp.	82.6	0.0	4.2	50.3	159.0

Table 22. (Cont.)

Taxon	Site 1	2	3	4	5
TRICHOPTERA	17.2	3.3	13.8	27.7	11.7
Glossosomatidae					
Anagapetus sp.	0.8	0.0	2.5	5.5	2.1
Glossosoma sp.	2.1	0.0	5.0	2.5	3.4
Hydropsychidae					
Arctopsyche sp.	2.1	0.0	0.0	2.9	0.8
Hydroptilidae					
Ochrotrichia sp.	0.4	0.0	0.0	0.0	0.0
Limnephilidae					
Ecclisomyia sp.	0.4	0.0	1.3	2.9	0.4
Imania sp.	0.0	0.0	0.0	0.0	0.4
Rhyacophilidae					
Rhyacophila acropedes	0.0	0.0	0.0	0.8	0.0
R. angelita	8.4	0.8	1.3	12.2	3.8
R. bifila	0.0	0.0	0.4	0.0	0.0
R. coloradensis	0.0	2.5	0.8	0.0	0.0
R. hyalinata	0.4	0.0	0.4	0.0	0.0
R. tucula	0.0	0.0	0.0	0.0	0.0
R. vagrita	0.0	0.0	0.8	0.0	0.0
R. verrula	0.8	0.0	0.0	0.0	0.0
R. sp. B	0.0	0.0	0.0	0.0	0.8
R. sp. C	0.0	0.0	0.4	0.4	0.0
R. sp. D	0.4	0.0	0.0	0.4	0.0
pupae indet.	1.3	0.0	0.8	0.0	0.0
COLEOPTERA	41.1	0.4	4.6	3.8	1.7
Elmidae					
Heterlimnius corpulentus					
- larvae	39.0	0.4	4.6	3.8	1.7
- adults	2.1	0.0	0.0	0.0	0.0
DIPTERA	537.7	75.9	535.2	244.1	827.6
Athericidae					
Atherix pachypus	1.7	0.4	0.0	0.0	1.3
Blepharoceridae					
larvae indet.	0.0	0.0	0.4	0.4	0.8
Bibiocephala sp. (pupae)	0.0	0.0	0.0	0.0	6.3

Table 22. (Cont.)

Taxon	Site 1	2	3	4	5
Chironomidae	450.5	68.4	502.5	229.8	766.8
Cricotopus sp.	79.3	2.1	135.5	39.8	255.5
Diamesa sp.	20.6	0.0	0.0	0.0	0.0
Eukiefferiella sp.	237.8	31.5	97.7	65.0	338.9
Micropsectra sp.	35.2	0.8	7.6	7.6	125.4
Orthocladius sp..	73.8	0.0	70.0	107.8	1.3
Parachlus sp.	0.4	0.0	0.4	0.0	0.8
Pseudodiamesa sp.	0.0	0.0	2.5	3.8	44.9
Rheotanytarsus sp.	2.1	5.0	18.0	0.0	0.0
Trichocladius sp.	0.0	6.7	0.8	5.0	0.0
Trissocladius sp.	1.3	22.2	169.9	0.8	0.0
Empididae					
larvae indet.	0.8	0.0	0.0	0.0	2.5
Heleidae					
Palpomyia sp.	53.7	5.5	10.5	5.0	2.1
Simuliidae					
Prosimulium sp. larvae	1.7	0.0	0.0	2.5	0.0
pupae indet.	2.9	0.0	0.0	0.4	0.4
Tipulidae					
Dicranota sp.	0.0	0.0	2.9	1.7	0.0
Hexatoma sp.	6.3	0.8	2.1	0.0	0.0
Ormosia sp.	0.0	0.0	0.0	0.4	0.0
Tipula sp.	7.6	0.0	2.1	0.4	0.4
pupae indet.	12.6	0.8	14.7	3.4	47.0
HYDRACARINA	0.8	0.0	0.0	0.4	0.0
NEMATODA	5.0	0.0	1.3	153.5	1.7
OLIGOCHAETA					
Limnodrilus sp.	23.9	0.0	7.6	46.1	17.6
TURBELLARIA					
Polycelis coronata	12.6	0.0	2.5	15.9	0.8
GRAND MEAN:	1372.5	125.8	862.8	997.9	1385.5

[a]Taxon or taxa indeterminate.

Table 23. Joe Wright Creek macroinvertebrate taxa and mean total density (organisms/m^2) from core samples (35 at site 1; 30 at sites 2-5) in fast water areas, June to October, 1979.

Taxon	Site 1	Site 2	Site 3	Site 4	Site 5
EPHEMEROPTERA	483.6	56.6	295.7	324.4	223.0
Baetidae					
Baetis bicaudatus	91.7	22.4	72.0	31.5	65.0
B. tricaudatus	6.6	0.7	2.8	11.2	2.1
Pseudocloeon sp.	0.6	1.4	3.5	0.0	1.4
Ephemerellidae					
Ephemerella coloradensis	31.8	0.0	4.2	7.0	1.4
E. doddsi	13.2	0.7	2.8	7.0	4.2
E. infrequens	19.8	0.0	2.8	5.6	1.4
Heptageniidae					
Cinygmula sp.	120.4	11.2	56.6	79.0	44.7
Epeorus deceptivus	99.5	13.3	100.7	48.2	62.2
Rhithrogena sp.	90.5	7.0	50.3	134.9	39.8
Leptophlebiidae					
Paraleptophlebia sp.	1.2	0.0	0.0	0.0	0.0
Siphlonuridae					
Ameletus sp.	8.4	0.0	0.0	0.0	0.7
PLECOPTERA	107.9	6.3	94.4	114.7	83.9
Capniidae					
Capnia sp.	6.6	0.0	3.5	2.1	5.6
Chloroperlidae					
indet.[a]	63.5	0.0	16.1	21.7	35.0
Nemouridae					
Malenka sp.	0.0	0.0	0.7	0.0	0.0
Podmosta sp.	0.6	0.0	0.0	0.7	0.0
Zapada cinctipes	0.6	0.0	0.0	0.0	0.0
Z. haysi	15.0	3.5	45.4	39.8	17.5
Perlodidae					
Isoperla sp.	0.6	2.8	0.7	1.4	1.4
Megarcys signata	9.0	0.0	8.4	8.4	2.8
Taeniopterygidae					
Taenionema	12.0	0.0	19.6	40.5	21.7

Table 23. (Cont.)

Taxon	Site 1	2	3	4	5
TRICHOPTERA	16.2	0.7	16.1	18.9	18.2
Glossosomatidae					
Anagapetus sp.	0.6	0.0	1.4	6.3	4.2
Glossosoma sp.	1.2	0.0	7.7	0.0	0.0
Hydropsychidae					
Arctopsyche sp.	1.2	0.0	0.0	0.7	0.0
Hydroptilidae					
Ochrotrichia sp.	0.0	0.0	0.7	0.0	0.0
Limnephilidae					
Ecclisomyia sp.	0.6	0.0	0.0	0.0	0.0
Rhyacophilidae					
Rhyacophila acropedes	0.6	0.0	3.5	0.7	0.0
R. angelita	9.0	0.7	0.0	9.1	2.1
R. coloradensis	0.0	0.0	0.7	0.0	0.0
R. hyalinata	0.0	0.0	0.0	0.0	1.4
R. tucula	0.0	0.0	0.0	0.0	1.4
R. vagrita	0.6	0.0	0.7	0.0	0.0
R. sp. B	0.0	0.0	0.0	0.0	0.0
R. sp. C	0.0	0.0	0.7	0.0	0.0
pupae indet.	2.4	0.0	0.7	2.1	10.5
COLEOPTERA	23.4	0.0	2.8	4.2	0.7
Dytiscidae					
larva indet.	0.0	0.0	0.0	0.0	0.7
Elmidae					
Heterlimnius corpulentus					
- larvae	22.8	0.0	2.8	4.2	0.0
- adults	0.6	0.0	0.0	0.0	0.0
DIPTERA	224.1	88.1	534.1	199.9	417.3
Athericidae					
Atherix pachypus	1.2	0.0	0.0	0.0	0.0
Blepharoceridae					
larvae indet.	0.0	0.0	0.7	2.1	3.5
Bibiocephala sp. pupae	0.0	0.0	2.8	2.1	3.5
Chironomidae	178.6	85.3	510.3	179.0	397.8
Cricotopus sp.	37.8	17.5	140.5	11.9	295.7
Diamesa sp.	10.8	0.0	0.0	0.0	0.0

Table 23. (Cont.)

Taxon	Site 1	2	3	4	5
Eukiefferiella sp.	89.3	46.1	100.0	30.8	73.4
Micropsectra sp.	13.2	2.1	13.3	5.6	5.6
Orthocladius sp.	27.0	0.0	100.7	114.0	0.0
Parachlus sp.	0.0	0.0	0.7	0.0	0.0
Pseudodiamesa sp.	0.0	0.0	12.6	9.8	13.3
Rheotanytarsus sp.	0.0	0.7	7.0	0.0	0.0
Trichocladius sp.	0.0	2.1	4.2	7.0	9.8
Trissocladius sp.	0.6	16.8	131.4	0.0	0.0
Dixidae					
Dixa sp.	0.0	0.0	0.0	0.0	1.4
Empididae					
larvae indet.	0.0	0.0	0.0	4.9	1.4
Heleidae					
Palpomyia sp.	34.8	2.1	10.5	7.0	4.2
Simuliidae					
Prosimulium sp. larvae	0.6	0.0	1.4	0.0	0.0
pupae indet.	0.6	0.0	0.0	0.0	0.0
Tipulidae					
Dicranota sp.	0.0	0.0	1.4	0.7	1.4
Hexatoma sp.	1.2	0.0	3.5	0.0	0.0
Ormosia sp.	0.0	0.7	0.0	0.0	0.0
Tipula sp.	3.6	0.0	0.0	0.0	0.0
pupae indet.	3.6	2.1	3.5	4.2	6.3
HYDRACARINA	0.0	0.0	0.7	0.0	0.0
NEMATODA	1.8	0.0	4.2	13.3	1.4
OLIGOCHAETA					
Limnodrilus sp.	4.2	4.2	25.2	47.5	22.4
TURBELLARIA					
Polycelis coronata	9.6	0.0	4.9	6.3	1.4
GRAND MEAN	870.7	158.0	978.0	729.2	766.9

[a]Taxon on taxa indeterminate.

Table 24. Mean total macroinvertebrate density values (organisms/m^2) by date, determined from 5 samples in slow water areas of Joe Wright Creek, June to October, 1979.

Date	Site 1	2	3	4	5
2-3 June	209.7	0.0	172.0	58.7	71.3
14 June	0.0	0.0	33.6	167.8	8.4
27-28 June	566.3	8.4	12.6	432.0	46.1
11-12 July	935.4	197.2	809.6	784.4	381.7
28 July	1002.5	159.4	700.5	1170.3	1984.1
10-11 August	1480.7	440.4	1891.8	1933.7	243.3
23 August	1656.9	67.1	1350.7	2751.7	725.7
6 September	1774.3	54.5	1803.7	970.0	3158.5
21 September	3309.5	289.5	1069.6	922.8	4001.7
5 October	2776.8	42.0	817.9	788.6	3238.2
GRAND MEAN	1372.5	125.8	862.8	997.9	1385.5
Total sample size	50	50	50	50	50

Table 25. Mean total macroinvertebrate density values (organisms/m^2) by date, determined from 5 samples in fast water areas of Joe Wright Creek, June to October, 1979.

Date	Site 1	2	3	4	5
2-3 June	385.9	4.2	146.8	71.3	8.4
27-28 June	293.6	—[a]	—[a]	—[a]	—[a]
11-12 July	964.8	167.8	440.4	121.6	595.6
28 July	1321.3	125.8	654.4	633.6	1942.1
10-11 August	1229.0	532.7	2395.1	1543.6	79.7
23 August	629.2	71.3	872.5	889.3	557.9
6 September	1283.5	46.1	1380.0	1111.6	1359.1
GRAND MEAN	874.4	158.0	978.0	729.2	766.9
Total sample size	35	30	30	30	30

[a]Sampling precluded by high discharge.

Table 26. Mean total macroinvertebrate biomass (g/m^2), determined using volume displacement of organisms in 5 samples from slow water areas, Joe Wright Creek, June to October, 1979.

Date	Site 1	2	3	4	5
2-3 June	1.17	0.00	1.68	0.92	0.13
14 June	0.00	0.00	0.34	0.59	0.08
27-28 June	3.31	0.04	0.13	1.51	0.42
11-12 July	3.52	0.38	2.31	6.00	2.18
28 July	4.15	0.55	2.39	7.42	5.12
10-11 August	7.26	0.92	3.06	6.00	0.42
23 August	5.49	0.17	2.14	4.07	3.10
6 September	9.19	0.84	3.73	5.03	4.95
21 September	12.00	1.93	4.36	4.78	4.87
5 October	8.26	0.13	10.86	5.96	17.07
GRAND MEAN	5.44	0.45	3.34	4.23	3.83
Total sample size	50	50	50	50	50

Table 27. Mean total macroinvertebrate biomass (g/m^2), determined using volume displacement of organisms in 5 samples from fast water areas, Joe Wright Creek, June to October, 1979.

Date	Site 1	2	3	4	5
2-3 June	1.76	0.04	0.38	0.21	0.04
27-28 June	0.38	—[a]	—[a]	—[a]	—[a]
11-12 July	2.89	0.42	3.15	0.88	2.06
28 July	11.07	0.76	2.81	2.31	4.32
10-11 August	4.15	1.51	8.01	5.08	0.13
23 August	4.19	0.42	1.64	2.01	4.07
6 September	8.22	1.17	1.59	4.82	5.62
GRAND MEAN	4.67	0.72	2.49	2.55	2.71
Total sample size	35	30	30	30	30

[a]Sampling of appropriate areas precluded by high discharges.

Table 28. Macroinvertebrate percentage composition by density from slow water samples, Joe Wright Creek, June to October, 1979.

Taxon	Site 1	2	3	4	5
Ephemeroptera	38.4	24.3	27.4	37.2	20.1
Plecoptera	15.1	1.0	7.1	13.5	17.7
Trichoptera	1.3	2.7	1.6	2.8	0.8
Coleoptera	3.0	0.3	0.5	0.4	0.1
Diptera	39.1	60.4	62.0	24.5	59.8
(Chironomidae)	(33.2)	(54.3)	(58.2)	(23.0)	(55.3)
Hydracarina	0.1	0.0	0.0	<0.1	0.0
Nematoda	0.4	0.3	0.1	15.4	0.1
Oligochaeta	1.7	10.7	0.9	4.6	1.3
Turbellaria	0.9	0.3	0.3	1.6	0.1
(Total sample size)	(50)	(50)	(50)	(50)	(50)

Table 29. Macroinvertebrate percentage composition by density from fast water samples, Joe Wright Creek, June to October, 1979.

Taxon	Site 1	2	3	4	5
Ephemeroptera	55.5	35.8	30.2	44.5	29.1
Plecoptera	12.4	4.0	9.6	15.7	10.9
Trichoptera	1.9	0.4	1.6	2.6	2.4
Coleoptera	2.7	0.0	0.3	0.6	<0.1
Diptera	25.7	55.8	54.6	27.4	54.4
(Chironomidae)	(20.4)	(54.0)	(52.2)	(24.5)	(51.9)
Hydracarina	0.0	0.0	0.1	0.0	0.0
Nematoda	0.2	1.3	0.4	1.8	<0.1
Oligochaeta	0.5	2.7	2.6	6.5	2.9
Turbellaria	1.1	0.0	0.5	0.9	<0.1
(Total sample size)	(35)	(30)	(30)	(30)	(30)

Table 30. Macroinvertebrate percentage composition by biomass from slow water samples, Joe Wright Creek, June to October, 1979.

Taxon	Site 1	2	3	4	5
Ephemeroptera	55.4	55.5	46.6	46.5	45.6
Plecoptera	15.1	2.8	38.2	30.2	29.6
Trichoptera	4.1	2.8	4.5	6.7	4.0
Coleoptera	2.9	0.9	0.6	0.6	0.3
Diptera	19.7	30.6	8.3	5.6	18.4
Hydracarina	0.4	0.0	0.0	0.1	0.0
Nematoda	0.4	0.9	0.4	5.3	0.2
Oligochaeta	0.8	5.6	0.8	2.1	0.9
Turbellaria	1.2	0.9	0.6	3.0	1.0
(Total sample size)	(50)	(50)	(50)	(50)	(50)

Table 31. Macroinvertebrate percentage composition by biomass from fast water samples, Joe Wright Creek, June to October, 1979.

Taxon	Site 1	2	3	4	5
Ephemeroptera	64.2	64.2	49.7	59.5	58.1
Plecoptera	14.9	8.7	26.7	18.1	14.2
Trichoptera	6.0	8.7	2.2	6.0	5.2
Coleoptera	1.7	0.0	0.8	0.8	0.8
Diptera	10.3	15.5	16.3	10.4	19.6
Hydracarina	0.0	0.0	0.3	0.0	0.0
Nematoda	0.4	1.9	0.8	1.1	0.3
Oligochaeta	0.4	1.0	1.7	1.9	1.5
Turbellaria	2.1	0.0	1.4	2.2	0.3
(Total sample size)	(35)	(30)	(30)	(30)	(30)

Table 32. Number of macroinvertebrate taxa in 5 samples from slow water areas, Joe Wright Creek, June to October, 1979.

Date	Site 1	2	3	4	5
2-3 June	10	0	5	5	2
14 June	0	0	2	6	2
27-28 June	18	2	3	12	7
11-12 July	19	5	17	23	19
28 July	24	9	22	29	22
10-11 JAugust	30	8	24	20	6
23 August	27	5	27	31	19
6 September	32	2	23	23	18
21 September	35	13	21	20	21
5 October	36	5	16	20	22
GRAND TOTAL	51	22	46	44	42
Total sample size	50	50	50	50	50

Table 33. Number of macroinvertebrate taxa in 5 samples from fast water areas, Joe Wright Creek, June to October, 1979.

Date	Site				
	1	2	3	4	5
2-3 June	12	1	4	3	1
27-28 June	13	— [a]	— [a]	— [a]	— [a]
11-12 July	20	9	15	10	14
28 July	23	6	22	21	24
10-11 JAugust	24	11	31	24	4
23 August	25	10	27	21	18
6 September	31	2	25	24	21
GRAND TOTAL	46	20	45	36	37
Total sample size	35	30	30	30	30

[a] Sampling of appropriate areas precluded by high discharge.

Table 34. Macroinvertebrate diversity index (Shannon-Weaver) values, $\bar{d}$, determined from actual number of organisms in 5 samples from slow water areas of Joe Wright Creek, June to October, 1979.

Date	Site 1	2	3	4	5
2-3 June	—[a]	—[a]	—[a]	—[a]	—[a]
14 June	—[a]	—[a]	—[a]	—[a]	—[a]
27-28 June	3.3	—[a]	—[a]	2.9	—[a]
11-12 July	3.4	—[a]	2.9	3.6	—[a]
28 July	3.7	—[a]	3.1	3.9	3.2
10-11 August	3.8	2.4	3.2	3.6	—[a]
23 August	3.8	—[a]	3.5	3.1	3.2
6 September	4.0	—[a]	2.7	3.2	2.3
21 September	3.8	—[a]	3.1	3.1	1.8
5 October	3.9	—[a]	2.7	2.5	2.9
Total diversity	4.4	3.5	3.8	4.1	3.6
Total sample size	50	50	50	50	50

[a]Insufficient number of organisms for valid analysis.

Table 35. Macroinvertebrate diversity index (Shannon-Weaver) values, $\overline{d}$, determined from actual number of organisms in 5 samples from fast water areas of Joe Wright Creek, June to October, 1979.

Date	Site 1	2	3	4	5
2-3 June	—[a]	—[a]	—[a]	—[a]	—[a]
27-28 June	—[a]	—[b]	—[b]	—[b]	—[b]
11-12 July	3.6	—[a]	3.3	—[a]	2.3
28 July	3.7	—[a]	3.5	3.4	2.6
10-11 August	4.0	2.8	3.5	3.8	—[a]
23 August	3.7	—[a]	3.7	3.5	3.4
6 September	4.0	—[a]	2.8	3.5	3.4
Total diversity	4.2	3.3	4.0	4.0	3.4
Total sample size	35	30	30	30	30

[a]Insufficient number of organisms for valid analysis.
[b]Sampling of appropriate areas precluded by high discharge.

Table 36. Macroinvertebrate equitability index values, e, determined from actual number of organisms in 5 samples from slow water areas of Joe Wright Creek, June to October, 1979.

Date	Site 1	Site 2	Site 3	Site 4	Site 5
2-3 June	—[a]	—[a]	—[a]	—[a]	—[a]
14 June	—[a]	—[a]	—[a]	—[a]	—[a]
27-28 June	0.8	—[a]	—[a]	0.8	—[a]
11-12 July	0.8	—[a]	0.6	0.8	—[a]
28 July	0.8	—[a]	0.6	0.8	0.7
10-11 August	0.7	0.8	0.6	0.9	—[a]
23 August	0.8	—[a]	0.6	0.4	0.7
6 September	0.8	—[a]	0.4	0.6	0.4
21 September	0.6	—[a]	0.6	0.6	0.2
5 October	0.6	—[a]	0.6	0.4	0.5
Total equitability	0.6	0.7	0.5	0.6	0.2
Total sample size	50	50	50	50	50

[a]Number of organisms insufficient for valid analysis.

Table 37. Macroinvertebrate equitability index values, e, determined from actual number of organisms in 5 samples from fast water areas of Joe Wright Creek, June to October, 1979.

Date	1	2	3	4	5
2-3 June	—[a]	—[a]	—[a]	—[a]	—[a]
27-28 June	—[a]	—[b]	—[b]	—[b]	—[b]
11-12 July	0.9	—[a]	0.9	—[a]	0.5
28 July	0.8	—[a]	0.8	0.7	0.3
10-11 August	1.0	0.9	0.5	0.8	—[a]
23 August	0.8	—[a]	0.7	0.8	0.8
6 September	0.7	—[a]	0.8	0.7	0.8
Total equitability	0.6	0.7	0.5	0.7	0.5
Total sample size	35	30	30	30	30

[a]Insufficient number or organisms for valid analysis.
[b]Sampling of appropriate areas precluded by high discharge.

Table 38. Mean length (L), weight (W), and coefficient of condition (K) for _Salmo clarki_ x _S. gairdneri_, Joe Wright Creek, 1979.

Site	Age Group	Year Class	No.	$\overline{L}$ (mm)	$\overline{W}$ (g)	$\overline{K}$
1	0+	1979	3	100.0	9.3	0.88
	I+	1978	14	123.5	19.9	1.06
	II+	1977	5	144.2	30.8	1.02
	III+	1976	7	164.0	48.3	1.10
	IV+	1975	4	202.3	98.0	1.19
	V+?	1974?	1	255.0	186.0	1.12
		Total:	34		Overall Mean:	1.06
2	I+	1978	4	124.0	21.8	1.15
	II+	1977	5	144.8	31.0	1.03
	III+	1976	2	169.5	46.0	0.94
	IV+	1975	2	206.0	92.0	1.03
		Total:	13		Overall Mean:	1.05
3U	I+	1978	5	102.2	10.4	0.93
	II+	1977	1	152.0	39.0	1.11
	III+	1976	7	197.1	76.9	1.00
	IV+	1975	4	226.3	118.3	1.00
		Total:	17		Overall Mean:	0.99
3	0+	1979	1	87.0	4.0	0.61
	I+	1978	1	130.0	16.0	0.73
	III+	1976	2	203.0	85.0	1.00
	IV+	1975	1	246.0	164.0	1.10
		Total:	5		Overall Mean:	0.89
4	I+	1978	3	113.7	17.3	1.08
	II+	1977	3	158.0	38.7	1.00
	III+	1976	2	193.5	79.0	1.09
	IV+	1975	1	235.0	124.0	0.96
		Total:	9		Overall Mean:	0.96
5	III+	1976	1	225.0	82.0	0.72
		Total:	79		Overall Mean:	1.03

Table 39. Average scale annulus radius measurements for <u>Salmo</u> <u>clarki</u> x <u>S. gairdneri</u> hybrids from Joe Wright Creek, 1979.

Site	Age Class	Year Class	No.	$\overline{L}$ (mm)	Average scale annulus radius (mmx80) S_{Total}	S_1	S_2	S_3	S_4
1	0+	1979	3	100.0	22.0				
	I+	1978	14	123.5	31.0	22.2			
	II+	1977	5	144.2	38.8	15.4	29.6		
	III+	1976	7	164.0	45.7	9.0	24.4	36.0	
	IV+	1975	4	202.3	41.5	9.8	19.3	28.3	35.3
	V+	?	1	255.0	58.0	(scales partially resorbed)			
2	I+	1978	4	124.0	27.0	21.5			
	II+	1977	5	144.8	35.0	12.2	31.6		
	III+	1976	2	169.5	43.5	10.5	21.5	34.5	
	IV+	1975	2	206.0	55.0	15.5	27.0	37.0	43.0
3U	I+	1978	5	102.2	20.4	19.8			
	II+	1977	1	152.0	42.0	14.0	21.0		
	III+	1976	7	197.1	44.0	11.9	22.1	34.9	
	IV+	1975	4	226.3	50.0	10.0	20.3	31.3	42.3
3	0+	1979	1	87.0	20.0				
	I+	1978	1	130.0	29.0	20.0			
	III+	1977	2	203.0	42.5	9.5	20.5	31.0	
	IV+	1976	1	246.0	39.0	7.0	13.0	22.0	31.0
4	I+	1978	3	113.7	29.3	21.3			
	II+	1977	3	158.0	31.7	19.0	25.0		
	III+	1976	2	193.5	38.0	13.0	22.5	31.0	
	IV+	1975	1	235.0	57.0	10.0	20.0	32.0	48.0
5	III+	1976	1	225.0	49.0	10.0	21.0	36.0	
GRAND TOTAL	0+	1979	4	96.9	21.5				
	I+	1978	27	118.8	28.2	21.5			
	II+	1977	14	147.9	36.1	14.9	28.7		
	III+	1976	21	185.0	44.0	8.0	22.7	34.5	
	IV+	1975	12	217.3	47.7	10.6	20.4	30.5	39.7
	V+	1974?	1	255.0	58.0	(scales partially resorbed)			

Table 40. Back-calculated growth (length) history for _Salmo clarki_ x _S. gairdneri_, Joe Wright Creek, 1979.

Age Group	Year Class	No.	Mean length (mm) at formation of annulus I	II	III	IV
I+	1978	27	90.1			
II+	1977	14	61.0	117.6		
III+	1976	21	33.6	95.4	145.1	
IV+	1975	12	48.3	92.9	138.9	180.9

Table 41. Back-calculated growth (weight) history for *Salmo clarki* x *S. gairdneri*, Joe Wright Creek, 1979.

Age Group	Year Class	No.	Mean weight (g) at formation of annulus I	II	III	IV
I+	1978	27	7.1			
II+	1977	14	2.1	16.1		
III+	1976	21	0.3	8.4	30.9	
IV+	1975	12	1.0	7.8	27.0	61.0

Table 42. Stomach contents of cutthroat x rainbow trout (*Salmo clarki* x *S. gairdneri*), Joe Wright Creek, 29 August and 22 September, 1979.

Taxon	Category: Frequency of Occurrence	Category: Percentage of Total Number	Category: Percentage of Total Volume	Order: Frequency of Occurrence	Order: Percentage of Total Number	Order: Percentage of Total Volume	Taxon: Frequency of Occurrence	Taxon: Percentage of Total Number
AQUATIC STAGES	100.0	45.1	22.2					
Ephemeroptera				88.9	13.7	10.9		
Baetidae								
Baetis sp.							55.6	1.7
Ephemerellidae								
Ephemerella coloradensis							22.2	0.4
Ephemerella doddsi							33.4	0.8
Heptageniidae								
Epeorus deceptivus							11.2	0.2
Rhithrogena sp.							33.3	5.5
Unidentifiable							66.7	3.8
Siphlonuridae								
Ameletus sparsatus							11.1	0.2
Exuvia							11.1	0.2
Unidentifiable							33.4	0.8
Plecoptera				49.3	4.0	3.4		
Nemouridae								
Zapada haysi							22.2	1.3
Perlodidae								
Isoperla sp.							11.1	0.4
Taeniopterygidae								
Taenionema sp.							22.2	1.1
Unidentifiable							33.4	1.3
Trichoptera				22.2	0.4	0.5		
Hydropsychidae								
Arctopsyche sp.							11.1	0.2
Limnephilidae								
Imania sp.							11.1	0.2
Coleoptera				11.1	0.2	0.2		
Elmidae								
Heterlimnius corpulentus							11.1	0.2
Diptera				88.9	25.4	6.5		
Chironomidae								
larvae							66.7	23.7
pupae							22.2	0.4
Heleidae								
Palpomyia sp.							11.1	0.2
Simuliidae								
larvae							33.3	1.1

Table 42. (Cont.)

Taxon	Category: Frequency of Occurrence	Category: Percentage of Total Number	Category: Percentage of Total Volume	Order: Frequency of Occurrence	Order: Percentage of Total Number	Order: Percentage of Total Volume	Taxon: Frequency of Occurrence	Taxon: Percentage of Total Number
Nematoda				33.3	1.3	0.7		
Unknown							33.3	1.3
ADULT (AERIAL) AQUATIC INSECTS	44.4	3.2	9.5					
Ephemeroptera				33.3	2.7	9.0		
Unidentifiable							33.3	2.7
Plecoptera				11.1	0.4	0.5		
Chloroperlidae								
Unidentifiable							11.1	0.2
Nemouridae								
Zapada haysi							11.1	0.2
TERRESTRIAL TAXA	100	51.7	46.4					
Coleoptera				66.7	10.9	12.0		
Unknown							66.7	10.9
Diptera				33.3	2.9	6.5		
Unknown							33.3	2.9
Hemiptera				88.9	22.9	9.3		
Lygaeidae							88.9	21.8
Unknown							33.3	1.1
Hymenoptera				66.7	14.7	18.5		
Formicidae							66.7	3.4
Unknown							22.2	11.3
OTHER MATERIAL	100	N/A*	21.9					
Detritus				22.2	N/A	1.6		
leaf							11.1	0.2
Inorganic Material				11.1	0.2	0.7		
stone							11.1	0.2
Unidentifiable Biotic Parts				100	N/A	19.7		
GRAND TOTAL:	N/A	100%	100%	N/A	100%	100%	N/A	100%

Stomachs examined: 9
Stomachs empty: 0

*N/A: Not Applicable

Table 43. Ivlev's Feeding Electivity Index values for stomach contents of seven cutthroat-rainbow trout hybrids collected at site 1, Joe Wright Creek, 29 August and 22 September 1979. (Macroinvertebrate availability data were calculated from 15 samples taken on 23 August and 21 September.)

Taxon	Index value
Ephemeroptera	-0.04
Plecoptera	-0.39
Trichoptera	-0.44
Coleoptera	-0.75
Diptera	0.17
Nematoda	0.71

Table 44. Mean length (L), weight (W), and coefficient of condition (K) for *Catostomus catostomus*, Joe Wright Creek, 1979.

Site	Age Group	Year Class	No.	$\overline{L}$ (mm)	$\overline{W}$ (g)	$\overline{K}$
2	V+	1974	1	299.0	230.0	0.86
3U	III+	1976	1	227.0	108.0	0.92
	IV+	1975	2	252.0	135.0	0.84
		Total:	3		Overall mean:	0.87
3	III+	1976	5	215.6	97.2	0.97
	IV+	1975	6	248.7	161.3	1.02
	V+	1974	1	335.0	316.0	0.84
		Total:	12		Overall mean:	0.98
4	IV+	1975	3	259.7	170.3	0.97
5	0+	1979	1	95.0	12.0	1.40
	II+	1977	2	117.0	12.0	0.75
	III+	1976	1	232.0	110.0	0.88
	V+	1974	1	286.0	186.0	0.80
		Total:	5		Overall mean:	0.92
GRAND TOTAL	0+	1979	1	95.0	12.0	1.40
	II+	1977	2	117.0	12.0	0.75
	III+	1976	7	219.6	100.6	0.95
	IV+	1975	11	252.3	162.0	0.98
	V+	1974	3	306.7	244.0	0.83
		Total:	24		Overall mean:	0.95

Table 45. Mean length and mean scale annulus radius annulus measurements for Catostomus catostomus, Joe Wright Creek, 1979.

Site	Age Class	Year Class	No.	$\bar{L}$ (mm)	Mean scale annulus radius (mmx80) S_{Total}	S_1	S_2	S_3	S_4	S_5
2	V+	1974	1	299.0	87.0	14.0	27.0	45.0	58.0	79.5
3U	III+	1976	1	227.0	67.0	16.0	31.0	52.0		
	IV+	1975	2	252.0	74.0	12.0	24.5	51.5	70.0	
3	III+	1976	5	215.6	72.2	13.2	26.2	47.6		
	IV+	1975	5	248.7	83.5	13.7	30.3	47.8	63.2	
	V+	1974	1	335.0	121.0	17.0	38.0	65.0	94.0	114.0
4	IV+	1975	3	259.7	81.3	12.3	29.3	47.7	64.3	
5	0+	1979	1	95.0	22.0					
	II+	1977	2	117.0	25.5	15.0	20.5			
	III+	1976	1	232.0	68.0	15.0	23.0	40.0		
	V+	1974	1	286.0	86.0	15.0	30.0	46.0	61.0	78.0
GRAND TOTAL	0+	1979	1	95.0	22.0					
	II+	1977	2	117.0	25.5	15.0	20.5			
	III+	1976	7	219.6	70.9	13.9	26.4	47.1		
	IV+	1975	11	252.3	81.2	13.0	29.0	48.5	64.7	
	V+	1974	3	306.7	98.0	15.3	31.7	52.0	71.0	90.3

Table 46. Back-calculated growth history (length) for Catostomus catostomus Joe Wright Creek, 1979.

Age Group	Year Class	No.	Mean total length (mm) at formation of annulus I	II	III	IV	V
II+	1977	2	100.7	109.2			
III+	1976	7	105.3	130.3	171.9		
IV+	1975	11	105.4	139.9	181.9	216.8	
V+	1974	3	113.2	151.6	199.1	243.5	288.7

Table 47. Back-calculated growth history (weight) for _Catostomus catostomus_ Joe Wright Creek, 1979.

Age Group	Year Class	No.	Mean total length (mm) at formation of annulus I	II	III	IV	V
II+	1977	2	10.0	12.7			
III+	1976	7	11.4	21.4	48.4		
IV+	1975	11	11.4	26.4	57.1	95.8	
V+	1974	3	14.1	33.4	74.5	134.9	222.8

Table 48. Length, weight, scale annuls data and coefficient of condition (K), Salmo gairdneri, Joe Wright Creek, 1979.

Site	Length (mm)	Weight (mm)	K	Mean scale annulus radius (mmx80) S_{Total}	S_1	S_2	S_3	S_4	S_5
3U	195	72	0.97	72	14	24	33	56	
5	232	140	1.12	94	9	22	35	58	80

Table 49. Fish population estimates (number per 100 m of stream), Joe Wright Creek, 1979.

Date / Taxon	Site 1	2	3U	3	4	5
29-30 August						
Hybrid trout	5.0	5.5	5.0	1.0	0.0	-
Longnose sucker	0.0	0.5	3.0	6.0	2.0	-
Rainbow trout	0.0	0.0	0.0	0.0	0.0	-
Unknown	0.0	0.0	0.0	0.5	1.5	
Total:	5.0	6.0	8.0	7.5	3.5	
22-23 September						
Hybrid trout	20.0	4.0	9.0	4.5	7.5	2.5
Longnose sucker	0.0	0.0	0.0	0.0	0.5	5.0
Rainbow trout	0.0	0.0	0.5	0.0	0.0	0.5
Unknown	0.0	0.0	0.5	0.5	0.0	3.0
Total:	20.00	4.0	10.0	5.0	8.0	11.0
(Mean value)	(12.5)	(5.0)	(9.0)	(6.25)	(4.25)	(11.0)

Salmo clarki x *S. gairdneri*
Catostomus catostomus
S. gairdneri
Fish seen but not caught.

Table 50. Substrate permeability values (k), Joe Wright Creek, 1979.

Date	Site	Sample Area Description	k(cm/hr)[a]
12 July	1,2,3,4,5	One measurement made at each site in area of slowest water and greatest accumulation of fine particles.	Exceeded equipment or operator ability.
29 July	1,2,3,4,5	As described for 12 July.	Exceeded equipment or operator ability.
29 August	5	Area of sand and gravel with negligible flow and abundant epilithon.	5000
	5	Area of sand and small gravel with moderate water flow.	8000
	4	Area below a small intermittent inlet with substrate composed largely of silt and sand.	2200
7 September	1	Slow water area with sand and gravel.	4400
	1	Fast water area with gravel and cobble.	3900
	2	Slow water area with gravel over cobble.	3500
	2	Fast water area, substrate well embedded.	5500
	3	Slow water area; sand and gravel predominant.	3000
	3	Fast water area; cobble predominant and well embedded.	6000
	4	Slow water area; cobble and gravel predominant.	3500
	4	Fast water area; cobble predominant.	5000

[a]All values corrected to 10°C.

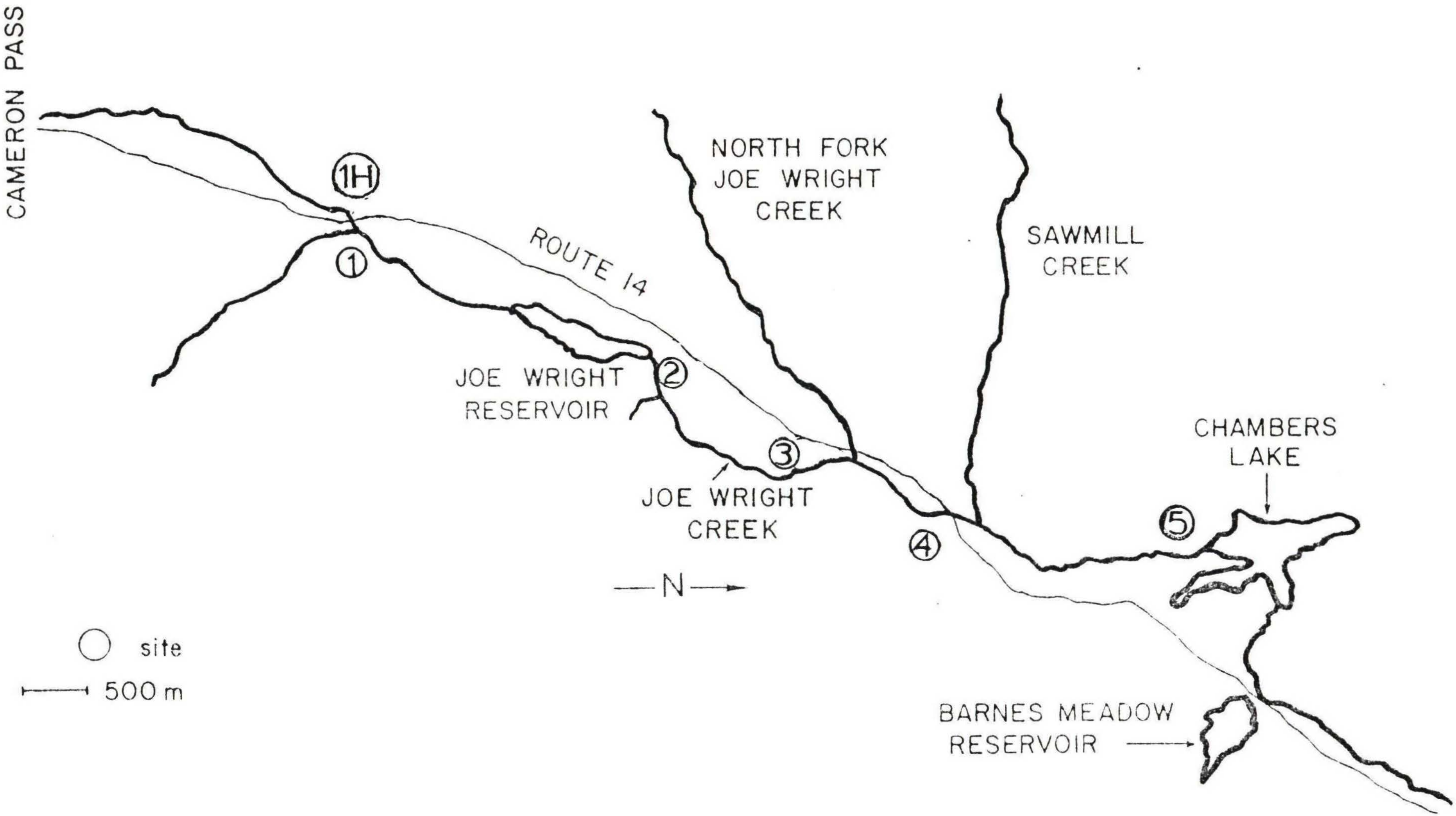

Figure 1. Joe Wright Creek Study Area, 1979.

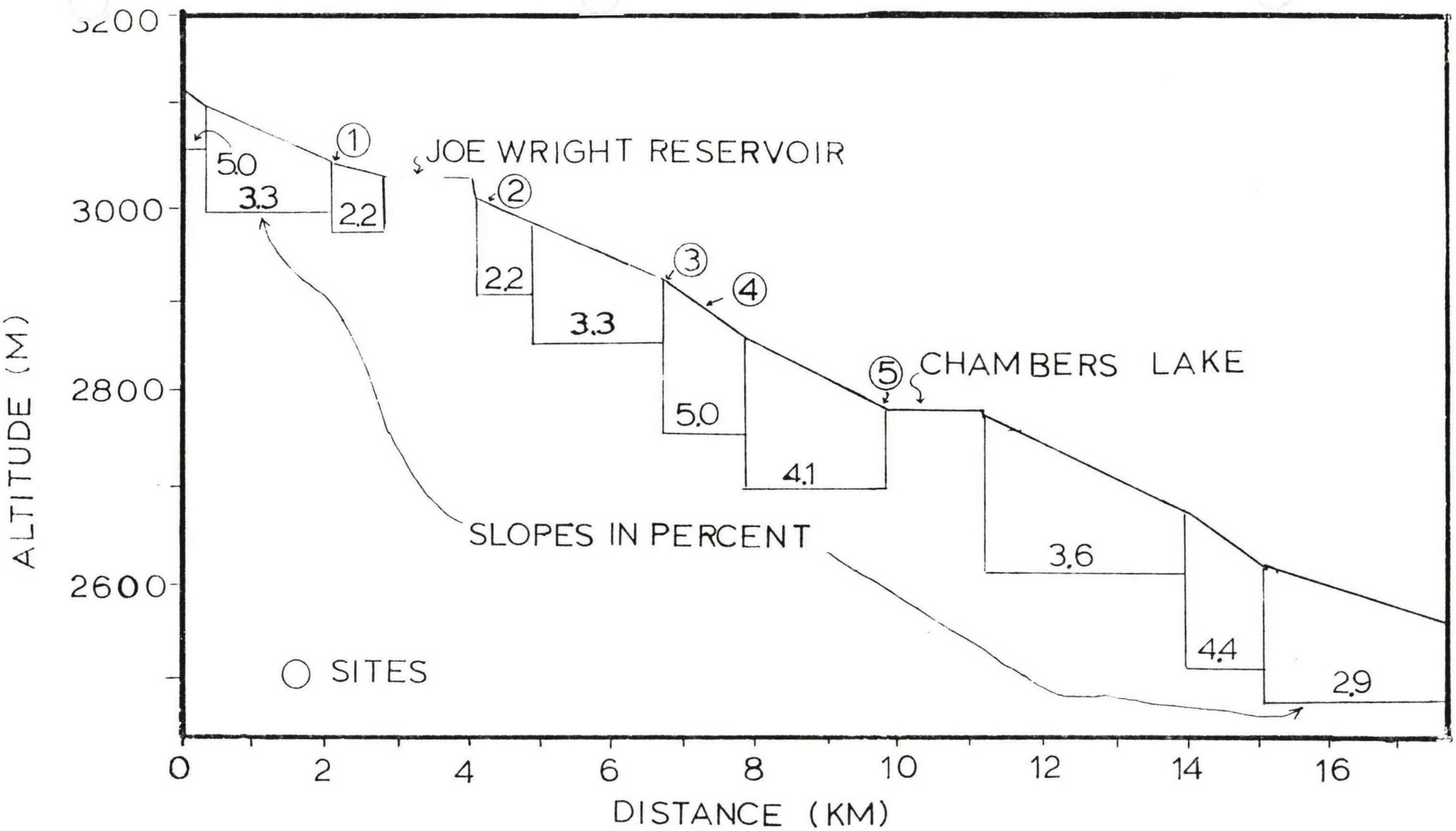

Figure 2. Vertical Profile, Joe Wright Creek (modified from Flook 1974).

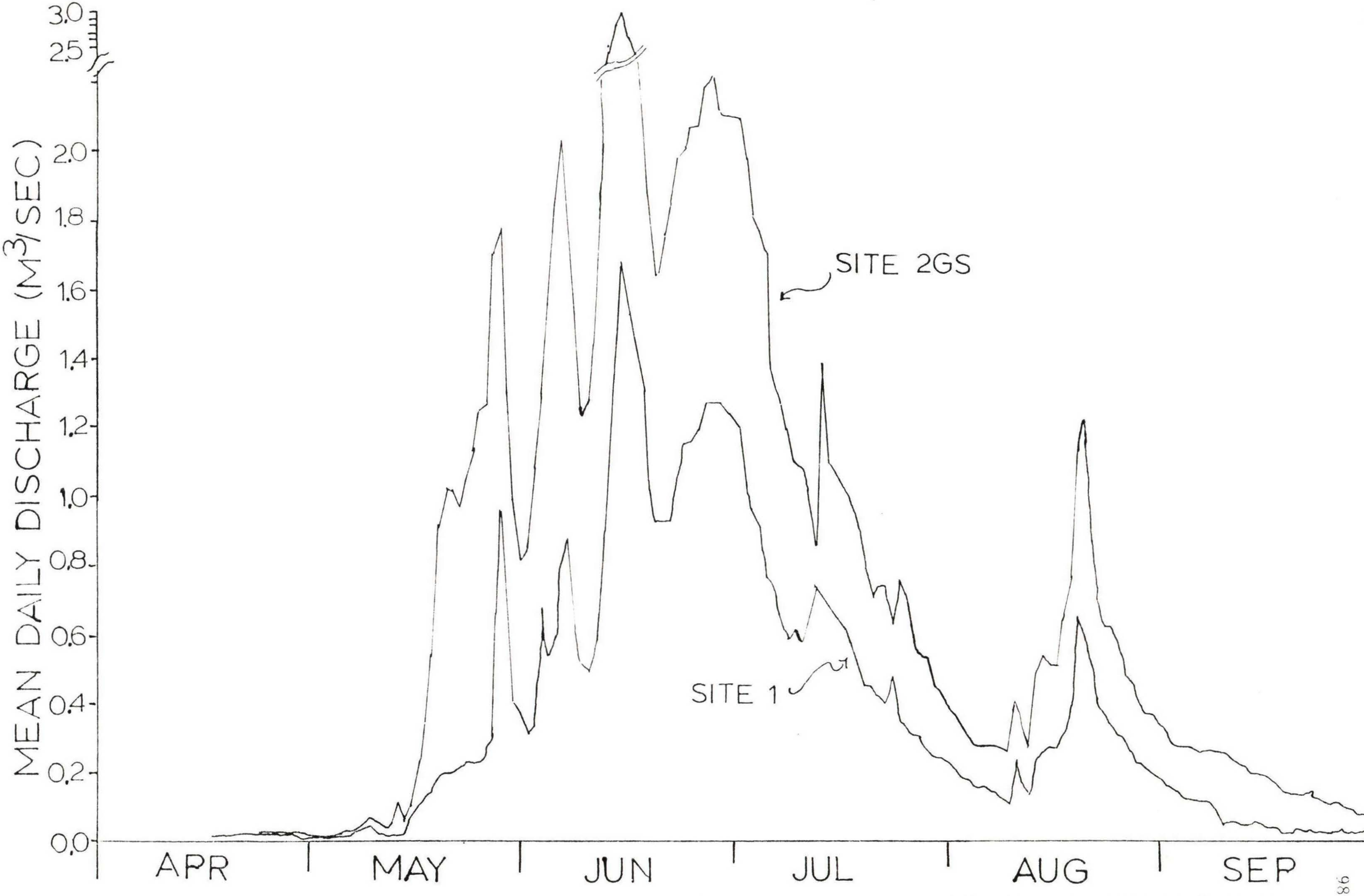

Figure 3. Mean daily discharge values for sites 1 and 2GS, Joe Wright Creek, 1979 (data from U.S. Geological Survey (1980), sites 06746100 and 06746110, respectively).

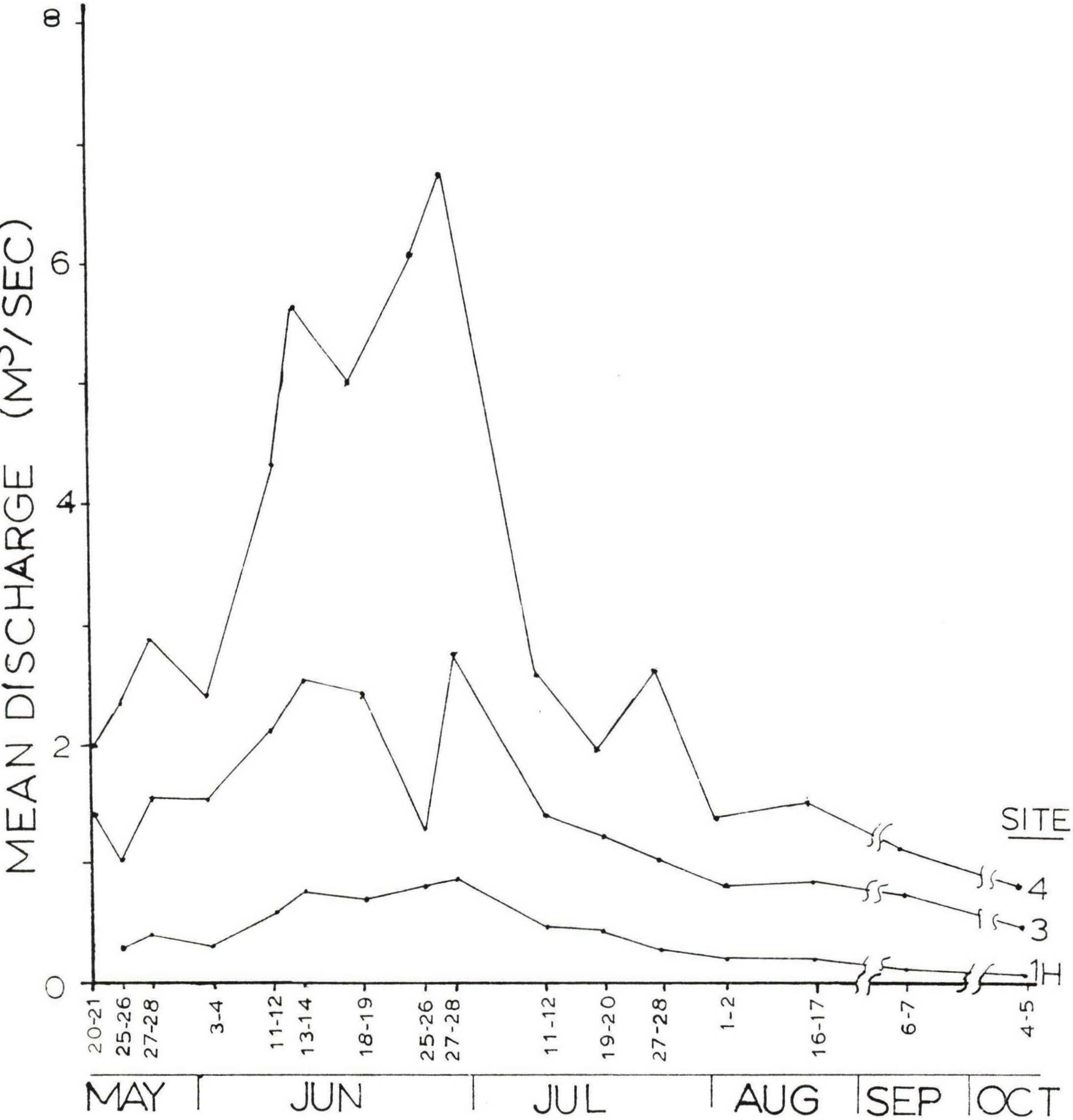

Figure 4. Mean discharge values based on 5 measurements per 24 hour period, Joe Wright Creek, 1979.

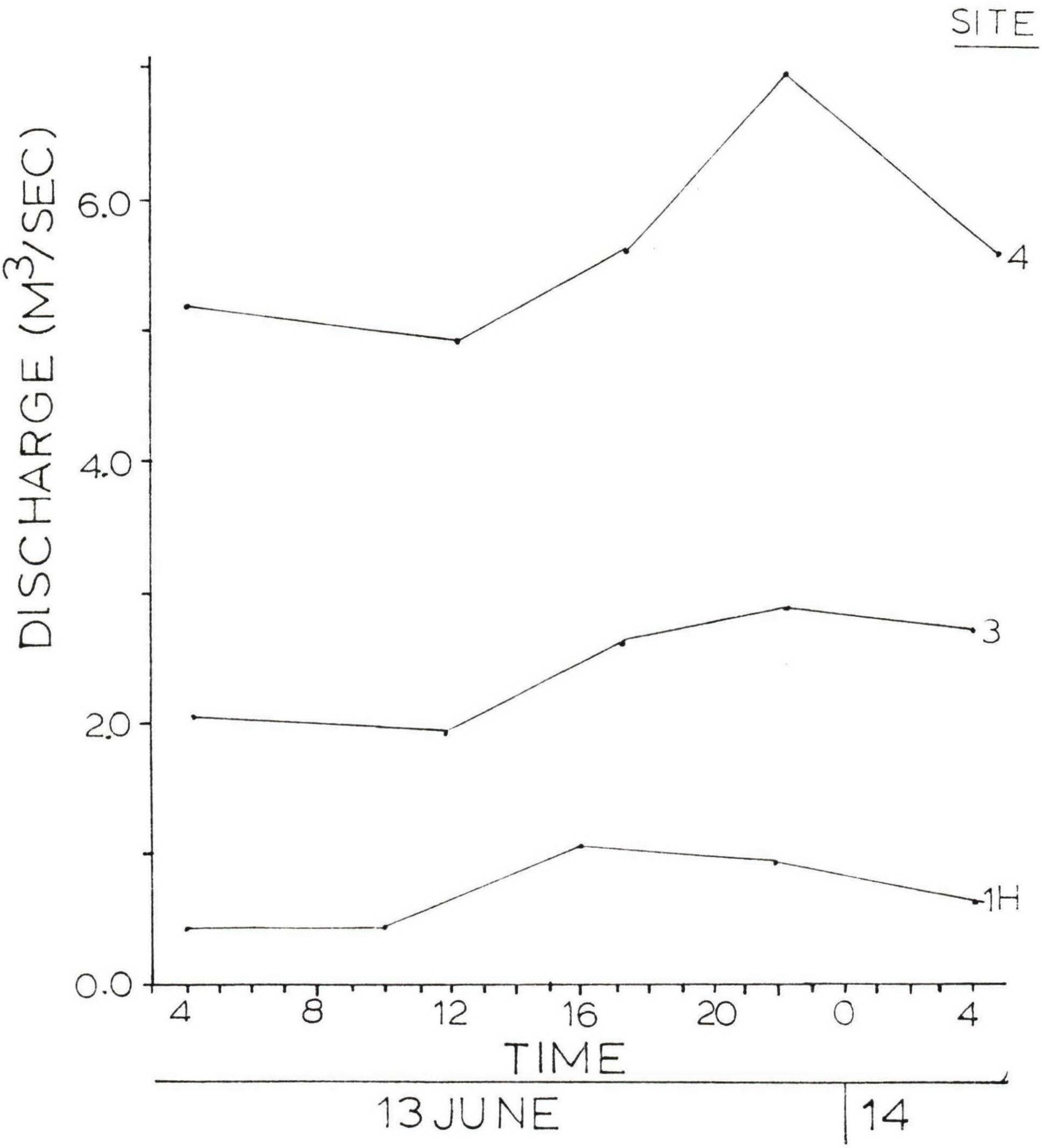

Figure 5. Diel variation of discharge, Joe Wright Creek, 13-14 June 1979.

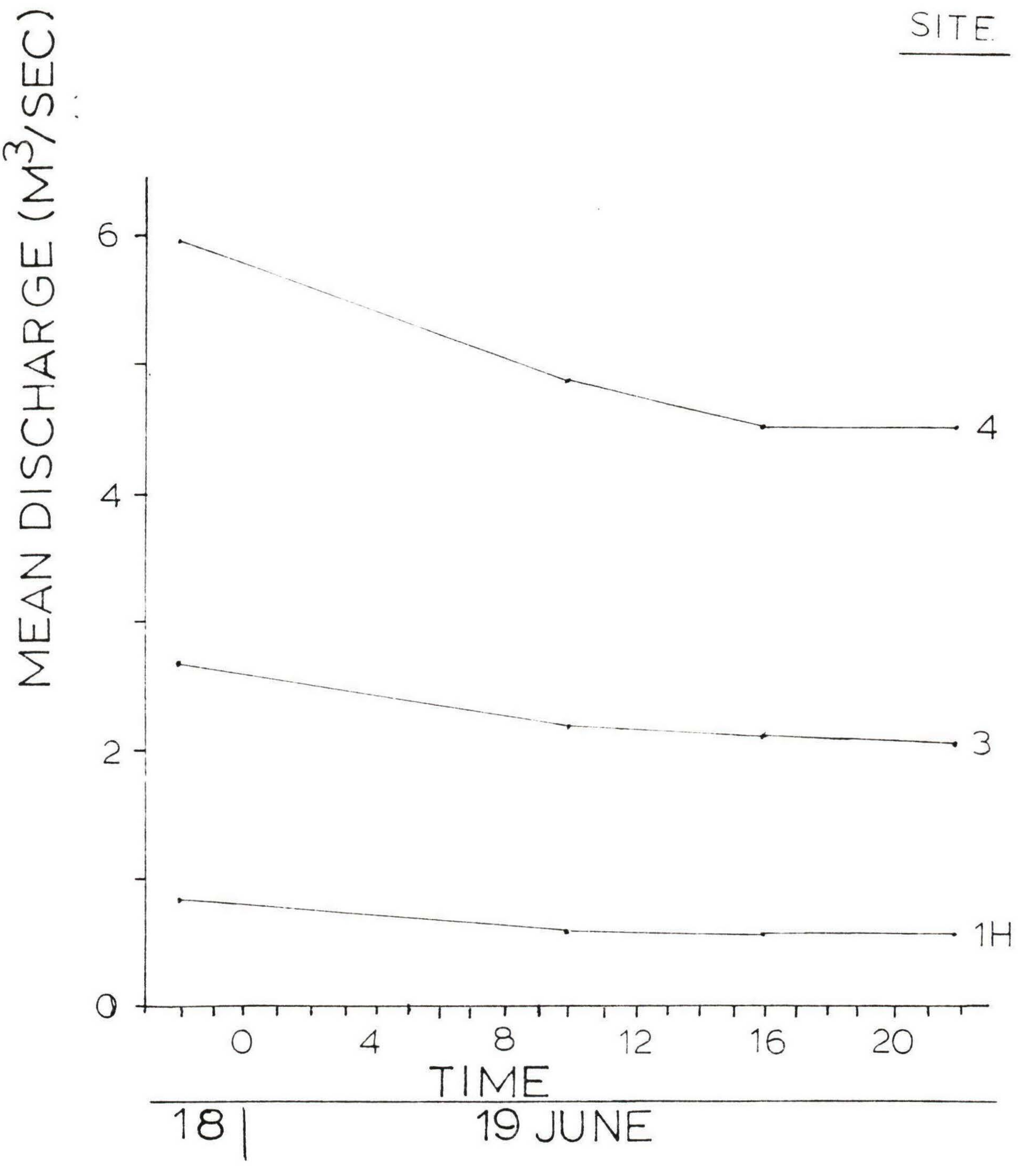

Figure 6. Diel variation of discharge, Joe Wright Creek, 18-19 June 1979.

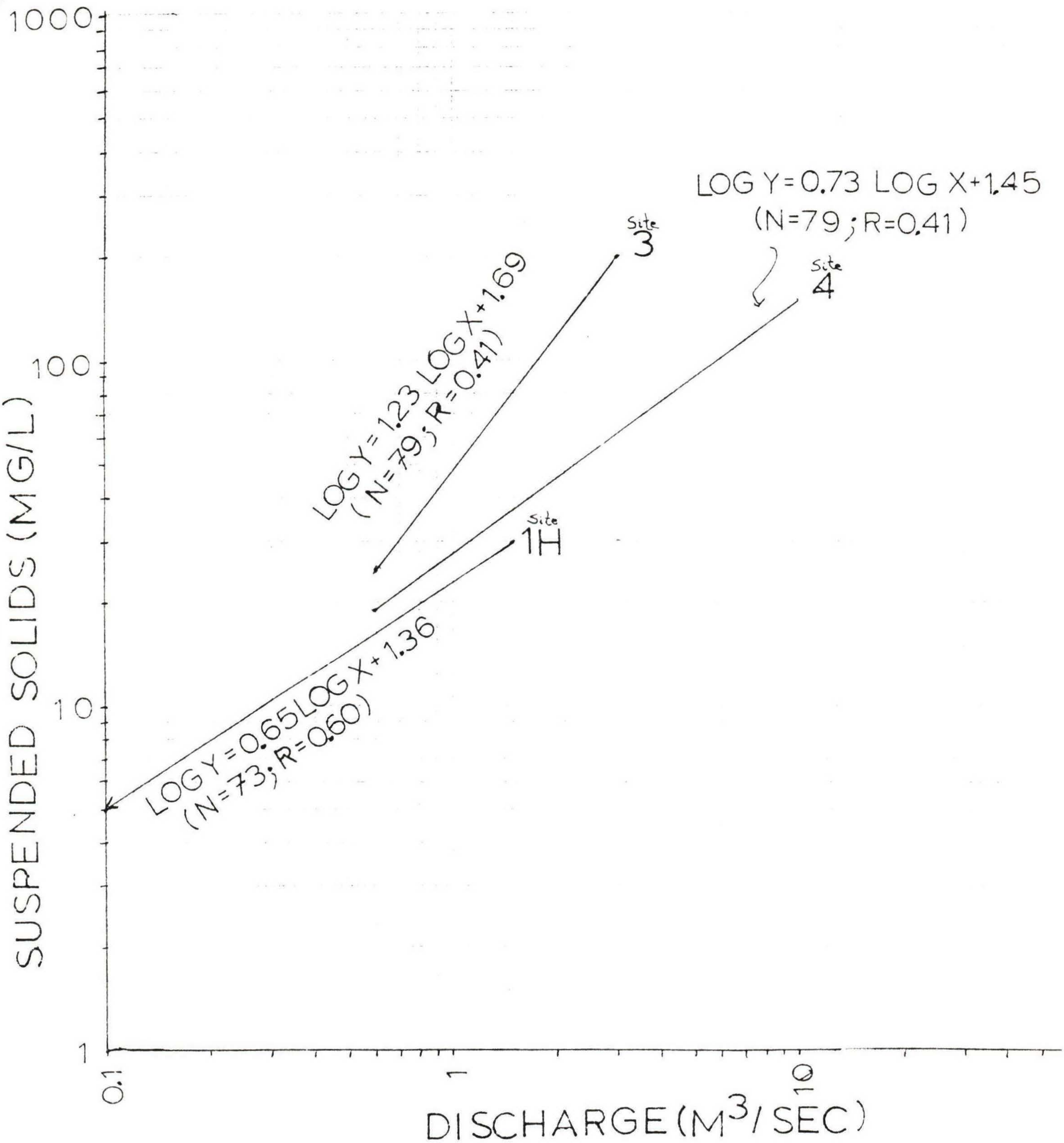

Figure 7. Suspended solids-discharge relationship, Joe Wright Creek, 1979.

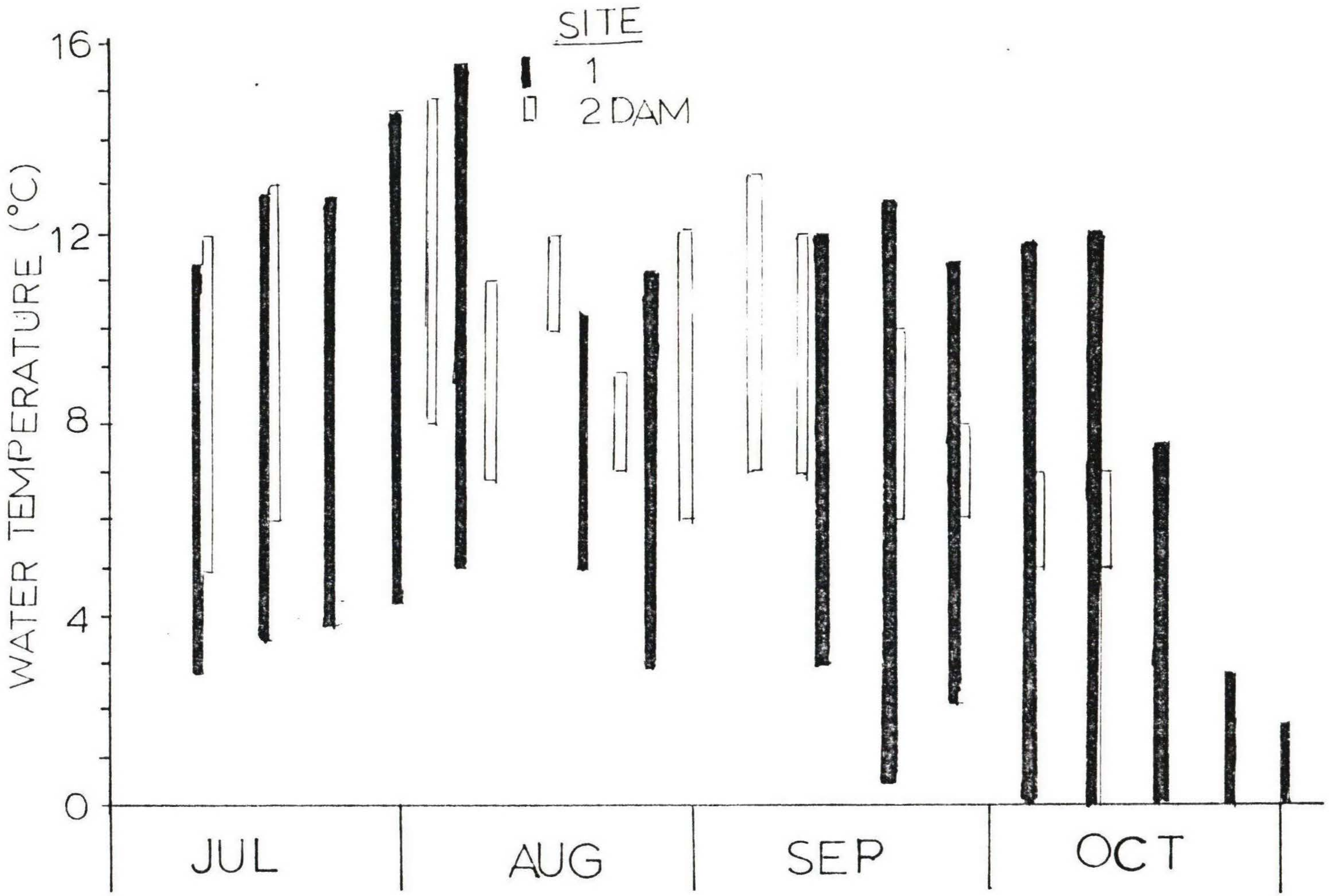

Figure 8. Range of average thermal minima and maxima for previous 5-7 days at sites 1 and 2DAM, Joe Wright Creek, 1979 (from tables 15-16).

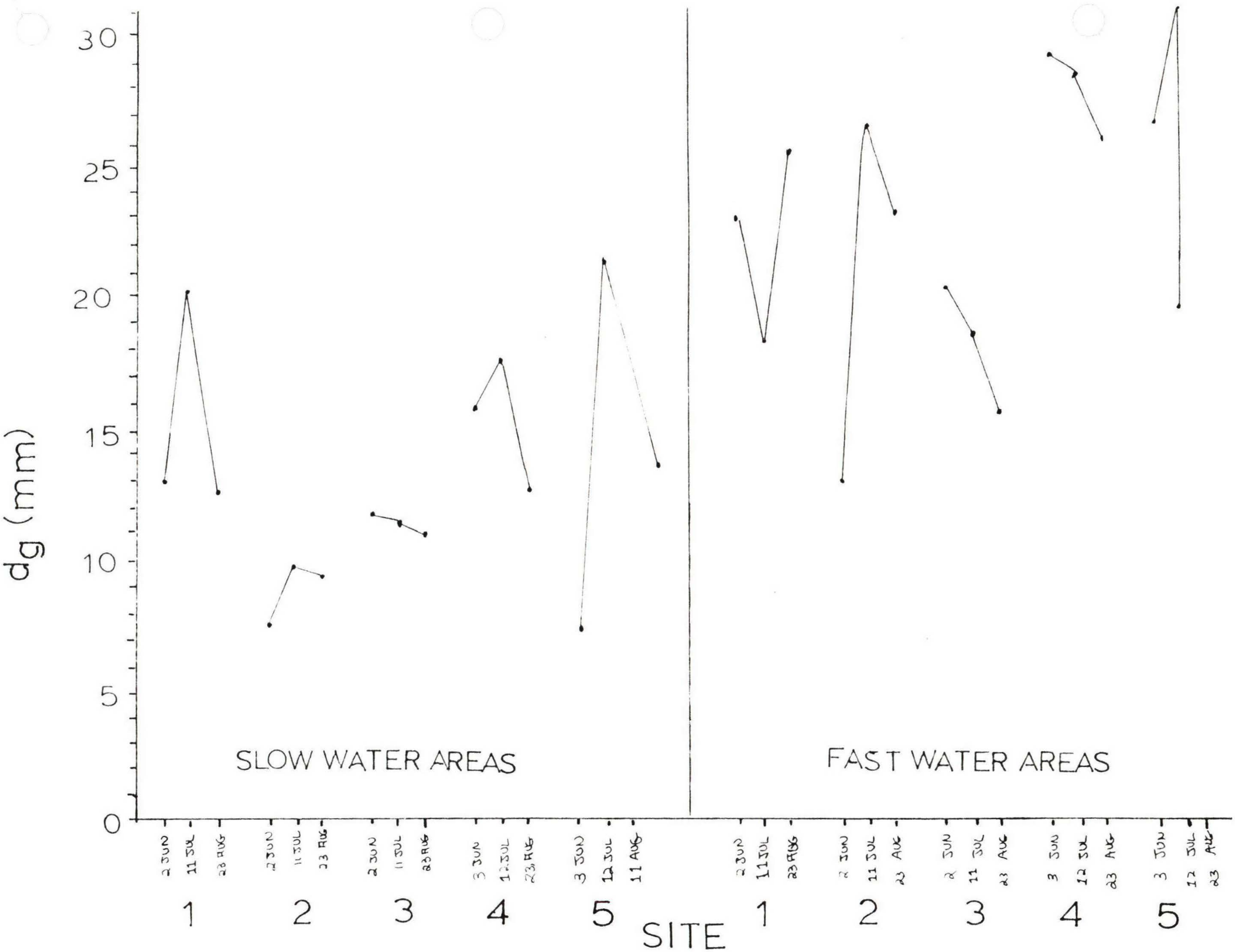

Figure 9. Mean (geometric) particle size, d_g, of substrate samples, Joe Wright Creek, 1979.

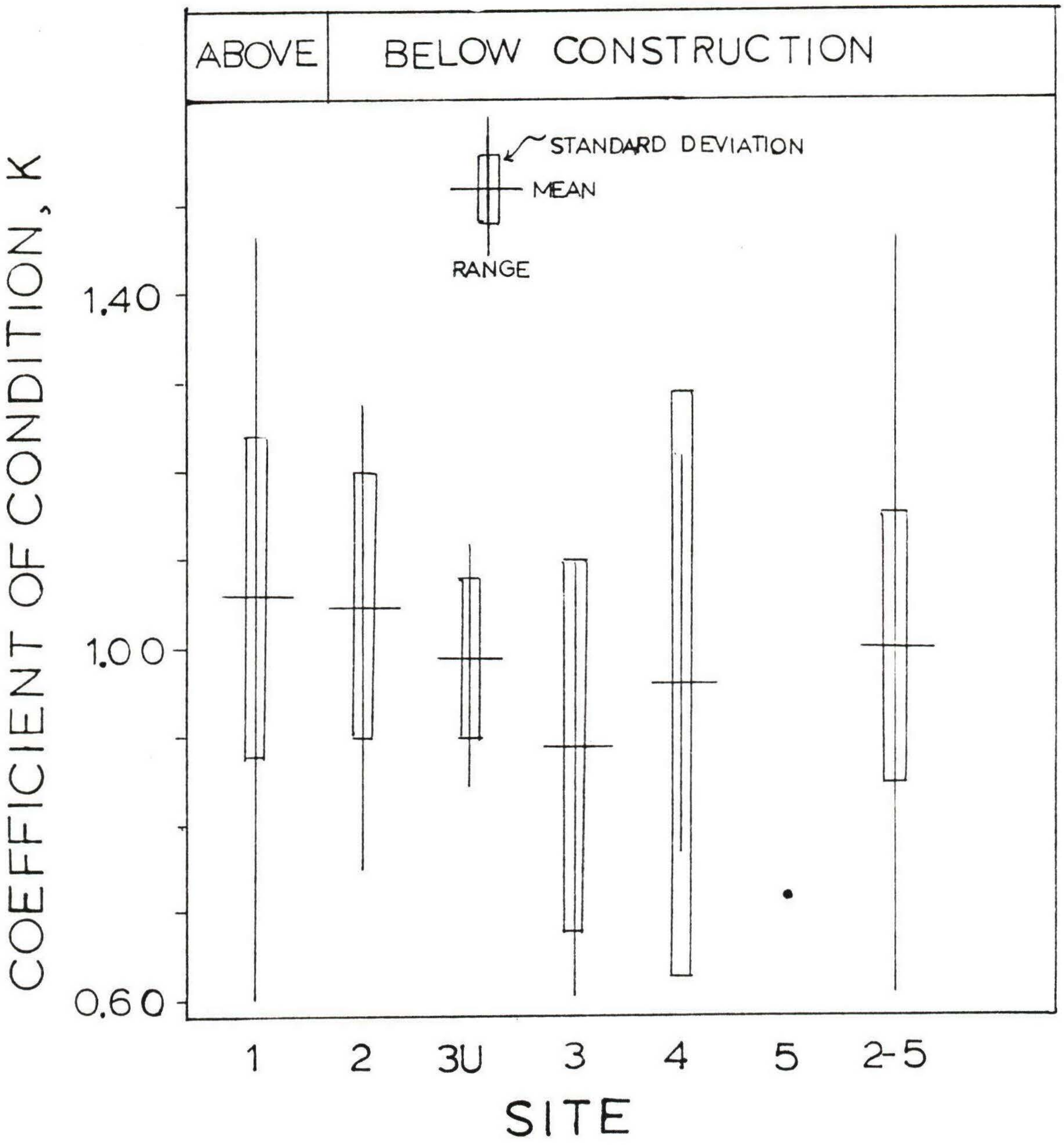

Figure 10. Mean, range, and standard deviation of the coefficient of condition, K, for Salmo clarki x S. gairdneri, Joe Wright Creek, 1979.

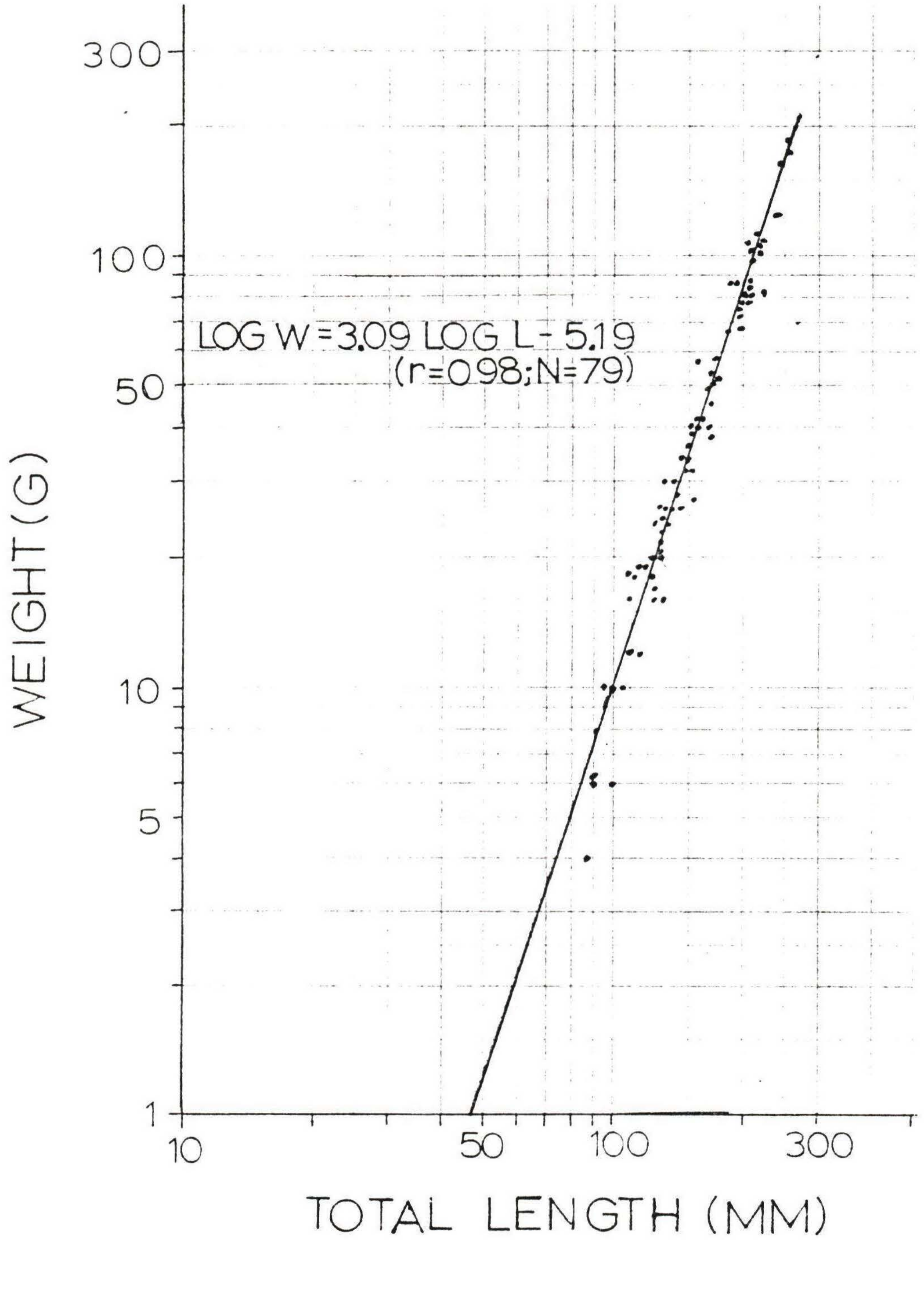

Figure 11. Length-weight relationship for _Salmo clarki_ x _S. gairdneri_, Joe Wright Creek, 1979.

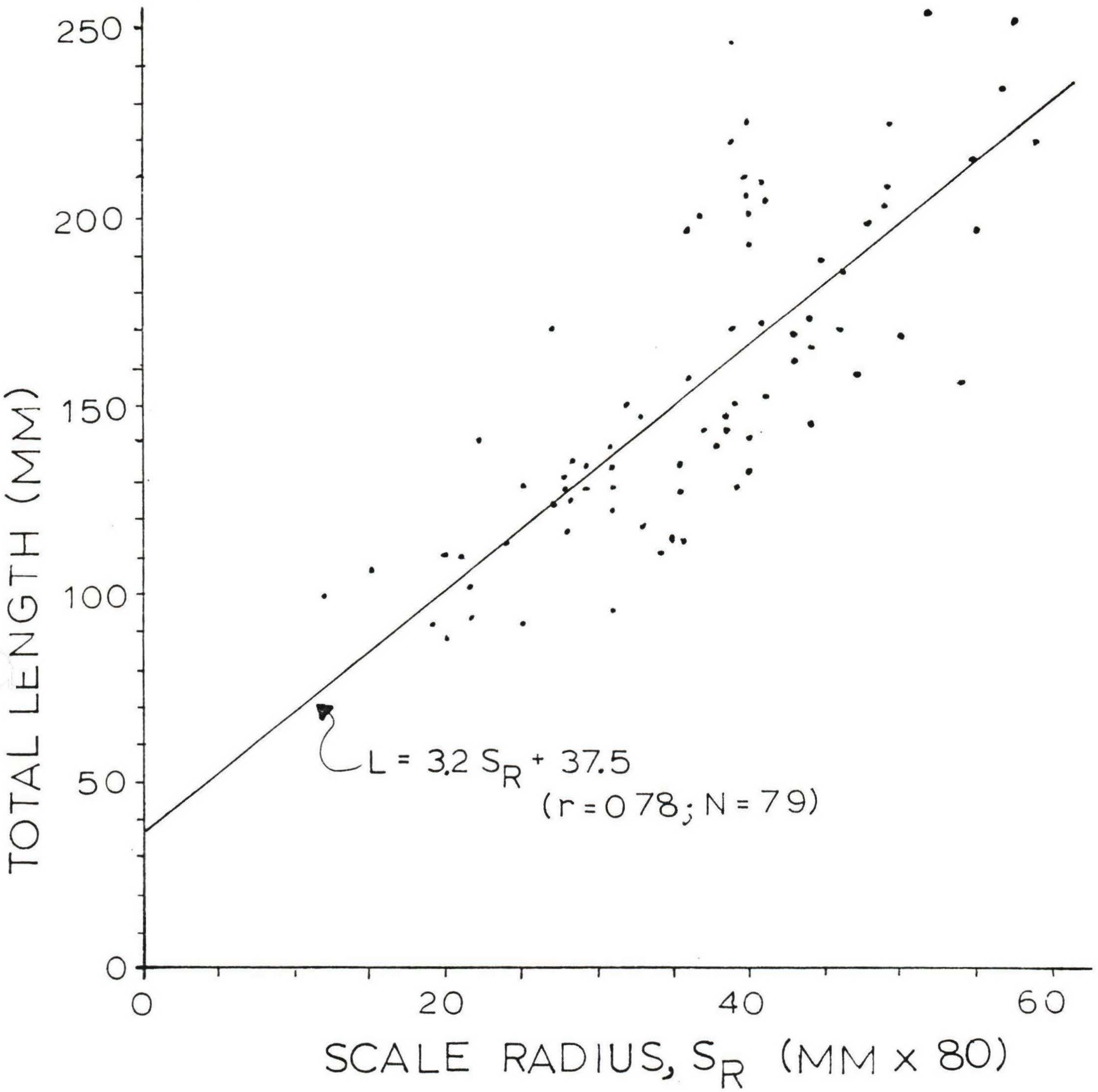

Figure 12. Scale radius-total length relationship for *Salmo clarki* x *S. gairdneri*, Joe Wright Creek, 1979.

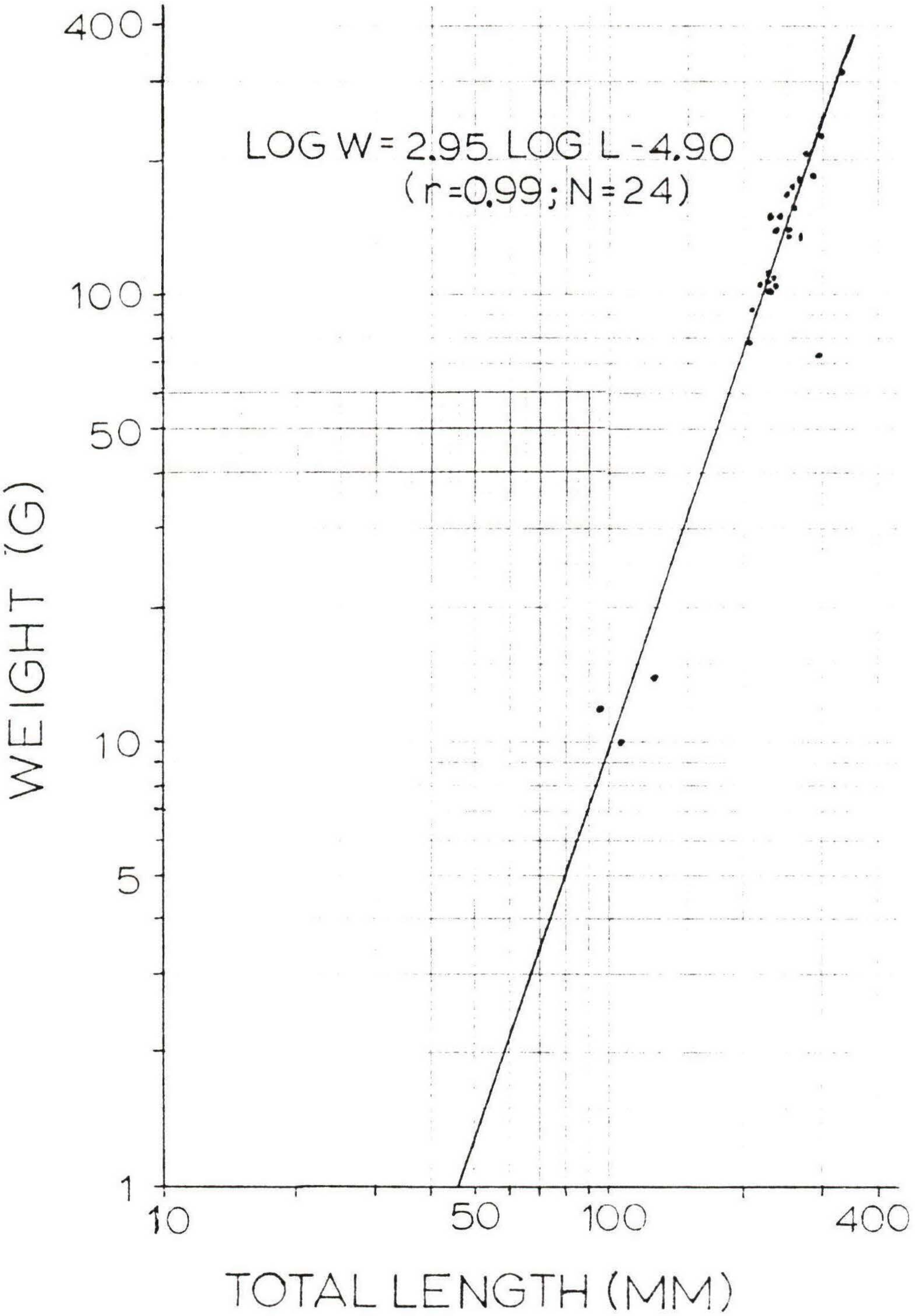

Figure 13. Length-weight relationship for Catostomus catostomus, Joe Wright Creek, 1979.

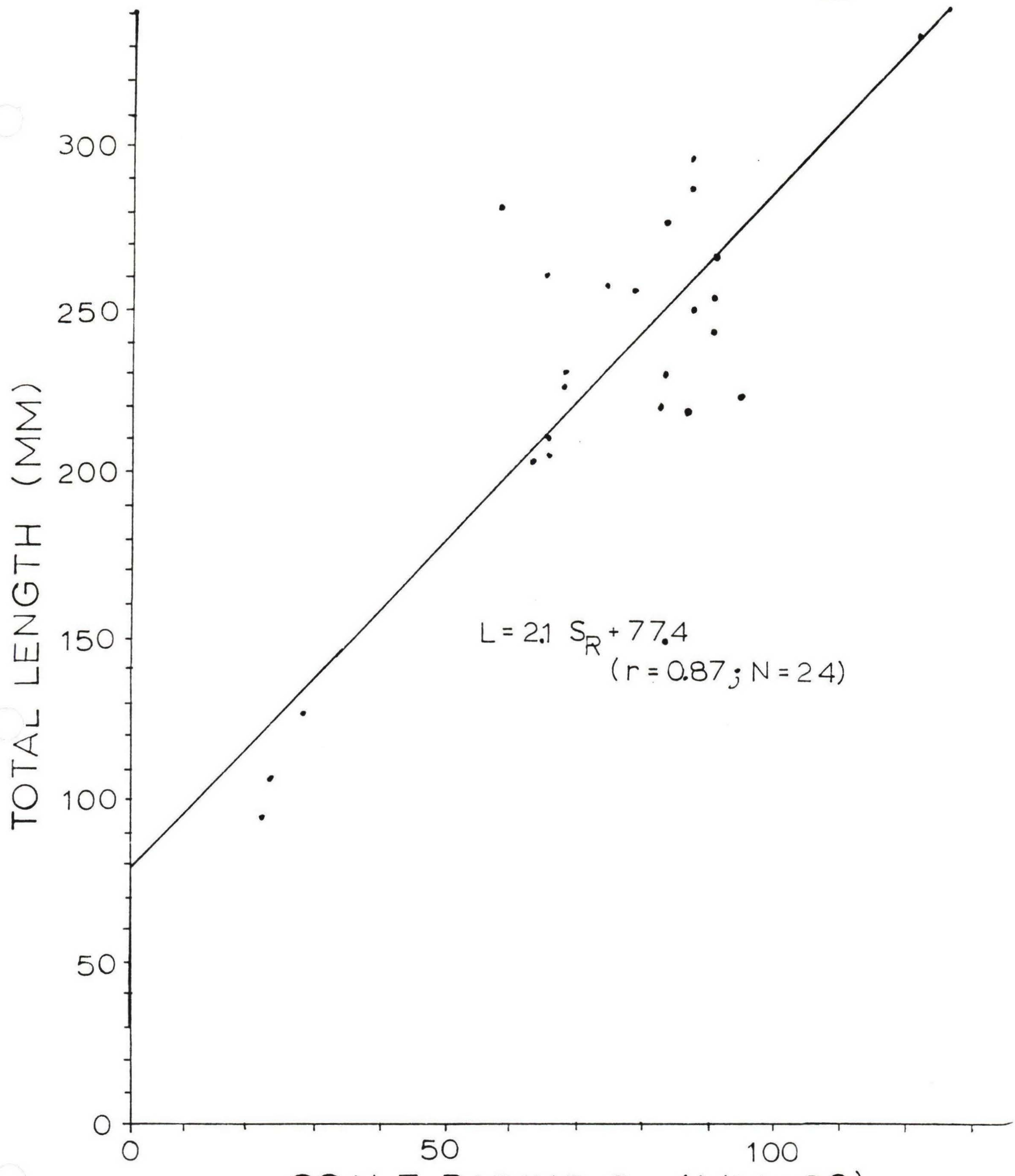

Figure 14. Scale radius-total length relationship for Catostomus catostomus, Joe Wright Creek, 1979.

Appendix A. Diel variation of suspended solids (mg/l), site 2, Joe Wright Creek, 1979.

Date[a]	Time	Total Suspended solids (mg/l)
20-21 May	1200	458.28
	1800	614.80
	1200	353.91
25-26 May	1110	299.05
	1705	522.0
	1115	731.28
27-28 May	1130	331.50
	1710	467.34
	1105	1791.08
3-4 Jun	1105	128.80
	1650	490.82
	1100	212.33
12 Jun	1105	94.21
	1655	389.21
13 Jun	1110	45.64
	1655	145.77
19 Jun	1100	54.21
	1650	18.87
26 Jun	1050	24.48
	1655	78.49
27-28 Jun	1700	54.72
	1105	25.88
	1645	41.99
11-12 Jul	1705	419.69
	1100	1008.19
	1655	253.77
20 Jul	1110	156.68
	1735	108.05
27-28 Jul	1640	13.45
	1015	15.30
	1700	15.29

Appendix A. (Cont.).

Date[a]	Time	Total Suspended solids (mg/l)
2 Aug	1050	6.54
	1645	9.07
17 Aug	1040	63.31
	1640	49.35
6-7	1635	42.87
Sep	1035	17.68
	1635	38.28
5 Oct	1035	642.94
	1615	73.32

[a]These sampling dates and times correspond to the same sampling at other sites.

Appendix B. Diel variation of suspended solids (mg/l), site 2DAM, Joe Wright Creek, 1979.

Date[a]	Time	Total Suspended solids (mg/l)
25-26	1030	375.85
May	1625	367.47
	1030	462.00
27-28	1040	321.95
May	1630	504.50
	1020	96.44
3-4	1025	114.04
Jun	1615	413.35
	1015	404.31
12	1025	59.00
Jun	1625	244.10
13	1030	41.98
Jun	1625	121.61
19	1035	56.38
Jun	1630	56.24
26	1025	30.40
Jun	1630	36.87
27-28	1625	48.93
Jun	1035	26.69
	1625	35.73
11-12	1630	58.60
Jul	1025	1485.72
	1625	456.98
19	1030	171.76
Jul	1715	116.38
12	1025	6.38
Aug	1620	9.51
16	1020	60.94
Aug	1620	46.48

Appendix B. (Cont.).

Date[a]	Time	Total Suspended solids (mg/l)
6-7	1615	45.83
Sep	1015	30.28
	1615	57.32

[a]These sampling dates and times correspond to the same sampling at other sites.